c) Special Number Traffic "11X"

In Medan and Semarang areas, special number traffic "11X" connections are handled wholly by newly established local tandem exchanges. In Solo area, handling of those connections is by individual local exchanges.

4) Local Tandem Exchange Establishment

In order to construct local junction network which can operate at reasonable cost, local tandem exchanges will be newly established in Medan and Semarang areas.

New tandem exchange functions are as under.

1) Trasit connections of local calls

2) Gateway function in overlay network

3) Centralized special number traffic routing

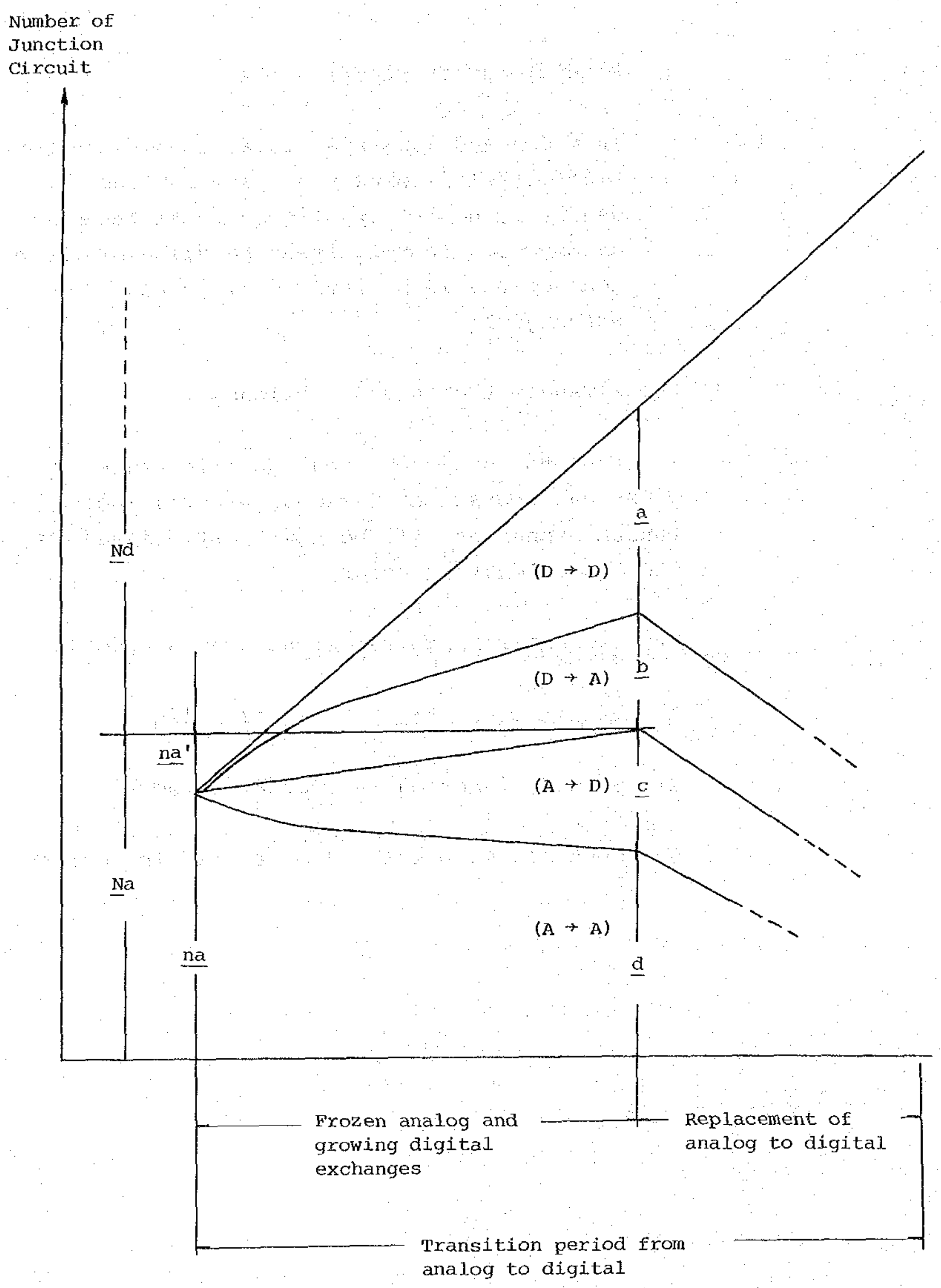


Figure 4-4-1 Change of Junction Circuit Requirements in Analog and Digital Co-Existing Network

Notations used in the illustrations are as under.

Nd: Total number of outgoing/incoming circuits at digital exchange

Na: Total number of outgoing/incoming circuits at analog exchange

na: Number of initial outgoing/incoming circuits at analog exchange

na: Increment in number of outgoing/incoming circuits at analog exchange

a: Number of digital to digital junction circuits

b: Number of digital to analog junction circuits

c: Number of digital to digital junction circuits

d: Number of digital to analog junction circuits

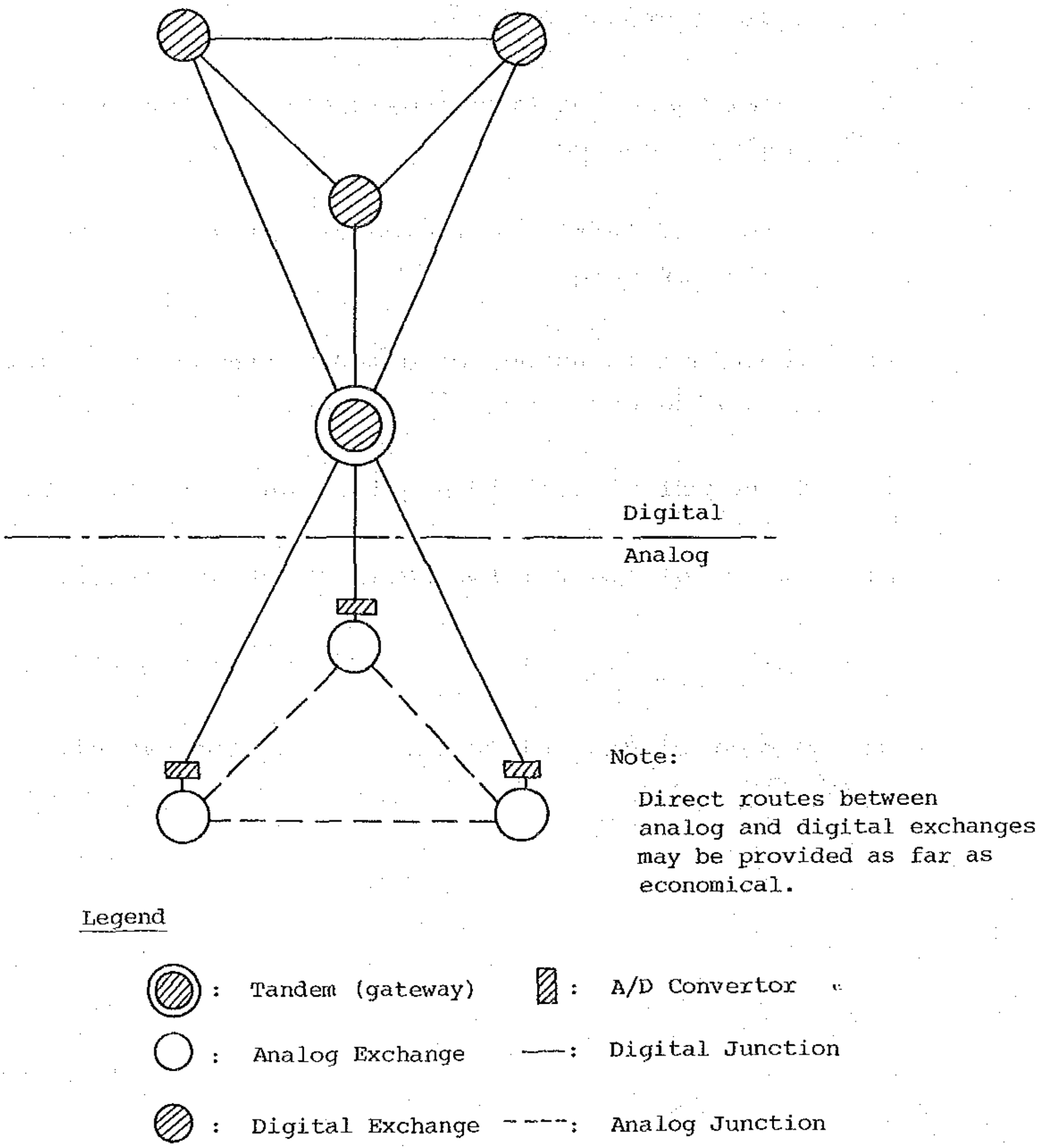


Figure 4-4-2 Analog and Digital Co-Existing Network (Overlay Network)

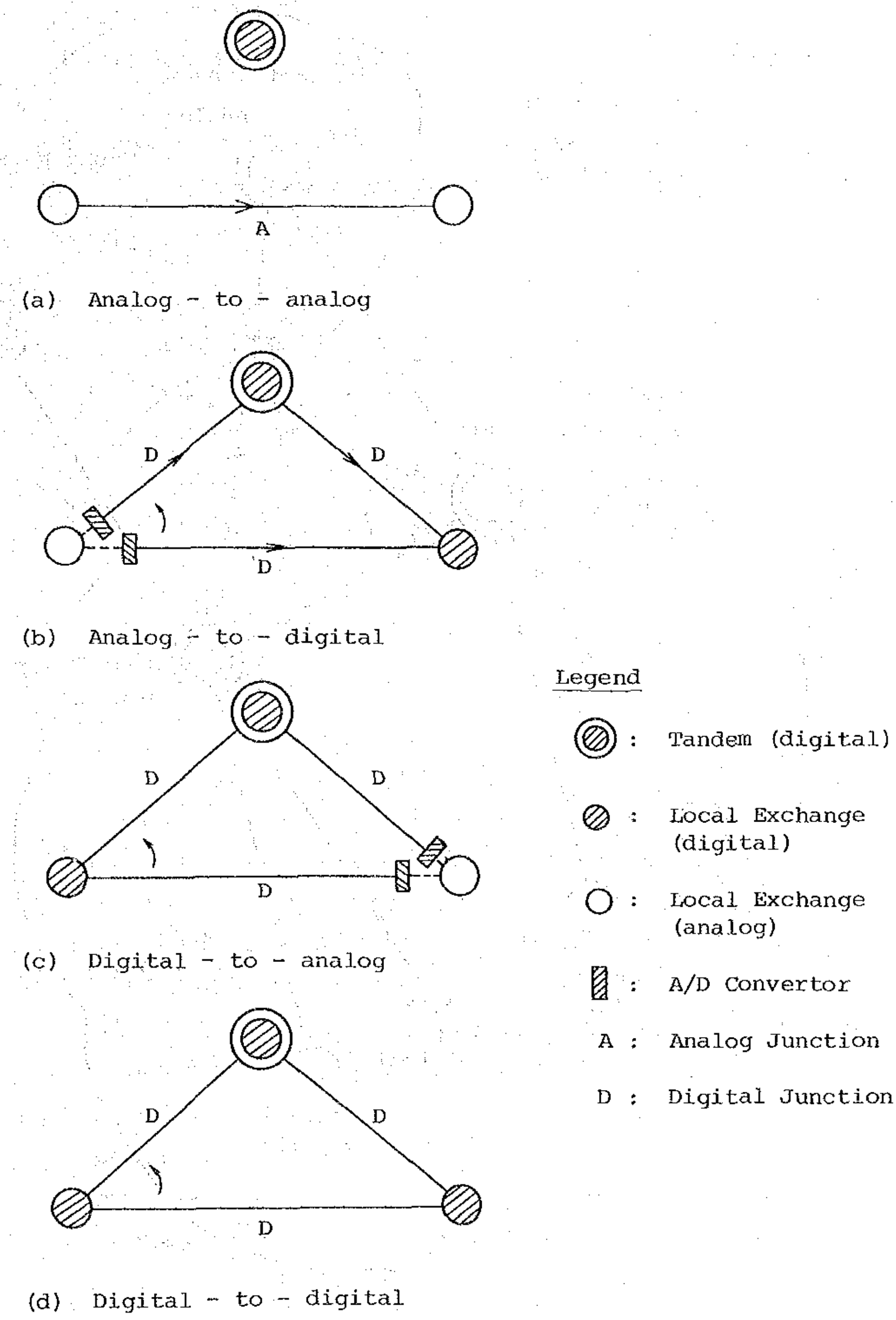


Figure 4-4-3 Traffic Routing in Local Junction Network

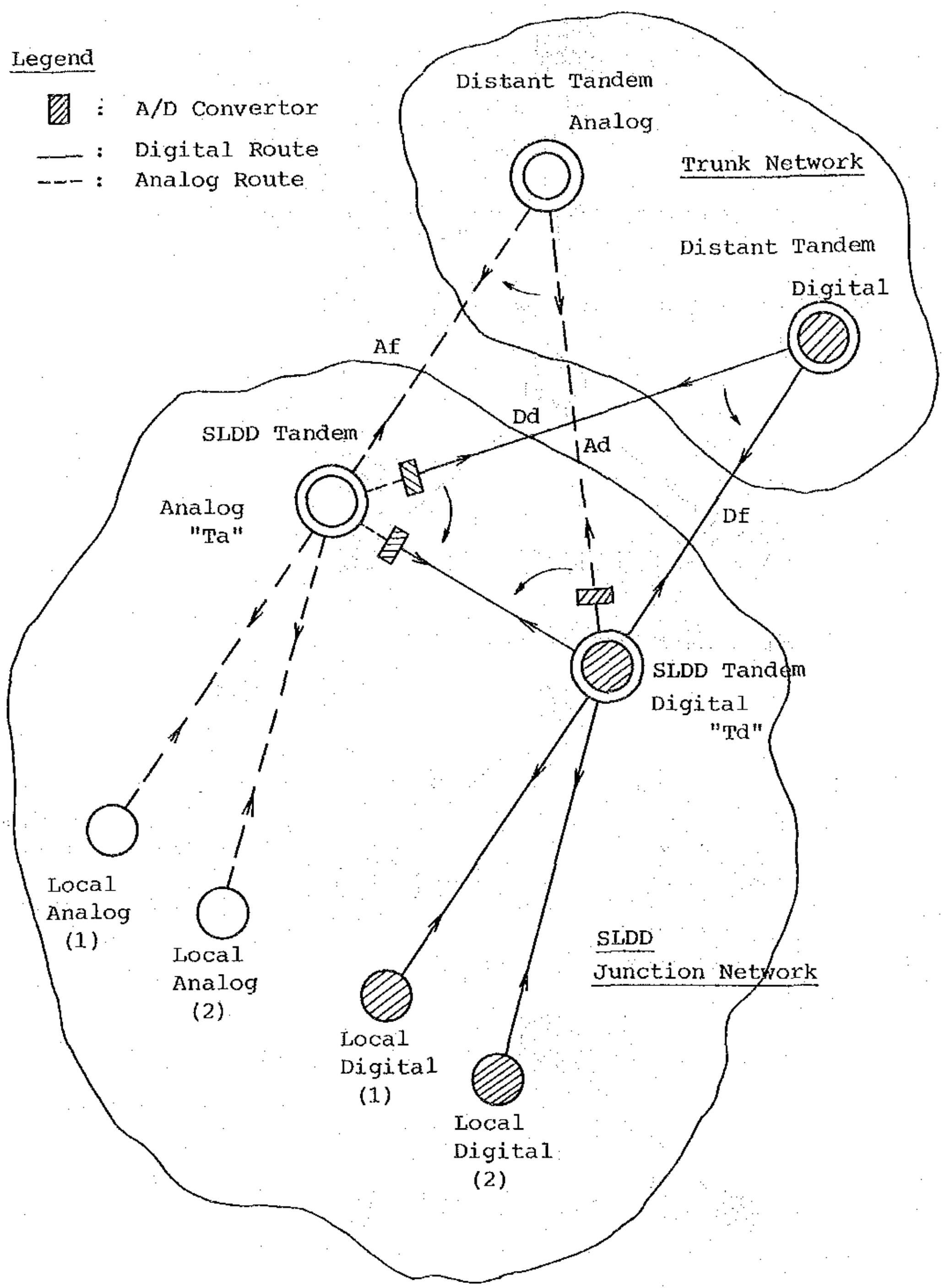


Figure 4-4-4 Traffic Routine in SLDD Junction Network

4-4-3 Signalling System

(1) Subscriber's Line Signalling Limits

According to PERUMTEL data, resistance limits by type of switching equipment used in objective cities are as under.

Type of Switching Equipment	Loop Resistance Limits
UR49-A	1,600 ohms
EWSD	1,800 ohms
MC10-C	1,500 ohms
ARF 101	1,500 ohms
ARF 102	1,500 ohms
EMD	1,500 ohms

(2) Inter-Exchange Signalling System

1) Line Signalling System

Objective cities of study, this time, are multi-exchange areas so that signalling system matching among different types of switches is necessary. Interface conditions between digital exchanges to be newly established are specified in CCITT Rec. G.732; hence no problem. However, for various combinations of connections anticipated between existing analog exchange and newly established digital exchange, interface conditions must be specified.

In existing analog telephone network of Indonesia, interface between switching systems wherein MFC resister signal is used, such as MC10-C and ARF 101 switching systems, is by uniform loop signalling as line signalling. For interface with EMD switching system, F-type line signalling is employed. Therefore, interface conditions between digital switching system (EWSD) and those analog switching systems are as under.

i) Interface by loop signalling

From EWSD to MC10-C
From EWSD to ARF 101

ii) Interface by F-type line signalling

From EWSD to EMD

The foregoing signalling arrangement details are in Table 4-4-2.

2) Resistor Signalling System

Semi-compelled type MFC signalling system is applied to EWSD, MC10-C, ARF 101 and ARF 102 switching systems. For EMD switching system, decimal type pulse signalling system is used. For details of MFC signalling system, refer to Table 4-4-3.

Table 4-4-2 (1/2) Line Signalling - Interface Between Analog and Digital Systems

(1) Signalling code for loop signalling

Signalling Status or Switching Signal	Signalling Word							
	forward ++ direction				backward ++ direction			
	af	bf	cf	df	ab	bb	cb	db
+ idel	1	0	0	1	1	0	0	1
+ seizing	0	0	0	1	1	0	0	1
+ seizing acknowledged	0	0	0	1	1	1	0	0
+ decadic dial pulse	1	0	0	1	1	1	0	1
+ answered	0	0	0	1	0	1	0	1
+ metering	0	0	0	1	1	1	0	1
+ clear back	0	0	0	1	1	1	0	1
forced release	0	0	0	1	0	0	0	1
+ clear forward (b party off-hook)	1	0	0	1	0	1	0	1
+ clear forward (b party on-hook)	1	0	0	1	1	1	0	1
+ release-guard = idle	1	0	0	1	1	0	0	1
+ blocked	1	0	0	1	1	1	0	1
or								
blocked	1	0	0	1	0	0	0	1
or								
blocked	1	0	0	1	0	1	0	1
channel individual failure	1	1	0	1	1	1	0	1

\+ Condition according to CCITT rec. Q 421

++ Bit position according to CCITT G.732 tab. 3

Table 4-4-2 (2/2) Line Signalling - Interface Between Analog and Digital Systems

(2) Signalling code for F-signalling

Signalling Status or Switching Signal	Signalling Word							
	forward ++ direction				backward ++ direction			
	af	bf	cf	df	ad	bb	cb	db
1. blocking - on					1	1	1	1
2. Idle (ready for seizuer)					0	1	1	1
3. Seizure	0	1	1	1				
4. Seizing acknowledged	0	1	1	1	1	1	1	1
5. dialing, on-hook (positive pot.)	0	0	1	1	1	1	1	1
6. end of dialing malicious call hold					1	0	1	1
7. trunk offering	0	1	0	1				
8. re-ring	0	0	0	1				
9. break	0	0	0	1				
10. answer					1	0	0	1
11. metering					1	1	0	1
12. Clear back					1	1	0	1
13. On-hook (nagat. pot.) start of mal. call	0	1	0	0				
14. end of mal. call hold					1	1	0	1
15. Clear forward	1	1	1	1				

Table 4-4-3 (1/2) Register Signals - Using SMFC Signalling

(1) Forward Signals

Code	Group I - Signals	Group II - Signals	Group III - Signals
1.	Digit 1	National operator	Digit 1
2.	Digit 2	Normal subscriber	Digit 2
3.	Digit 3	Local coinbox	Digit 3
4.	Digit 4	International Operator	Digit 4
5.	Digit 5	Long distance coinbox	Digit 5
6.	Digit 6	National test equipment	Digit 6
7.	Digit 7	International test equipment	Digit 7
8.	Digit 8	Spare	Digit 8
9.	Digit 9	Spare	Digit 9
10.	Digit 10	Spare	Digit 10
11.	Reroute to special service	Spare	Spare
12.	Spare	Sare	Spare
13.	Spare	Spare	Spare
14.	Access to maintenance equipment	Spare	Spare
15.	End of available information	End of available information	End of available information

Table 4-4-3 (2/2) Register Signals - Using SMFC Signalling

(2) Backward Signals		
Code	Group A - Signals	Group B - Signals
1.	Send next digit (n + 1)	Subscriber line free with metering
2.	Restart from beginning	Subscriber busy
3.	End of selection/change to B-signalling	Interception (change number and dead line)
4.	Congestion	Spare
5.	Set-up speech condition/ through switching	Spare
6.	Send categ. of calling subscriber. Subsequent A6 request A party number.	Malicious call tracing
7.	Spare	Spare
8.	Send last digit but one (n-1)	Spare
9.	Send last digit but two (n-2)	Spare
10.	Spare	Spare
11.	Spare	Spare
12.	Spare	Spare
13.	Spare	Spare
14.	Spare	Spare
15.	Spare	Spare

4-4-4 Transmission Plan

In Indonesia, telecommunications network digitalization is being carried out on nationwide scale. After full network digitalization, local exchanges are interconnected by digital circuits so that transmission performance (transmission loss, noise figure, attenuation distortion, etc.) is expected to improve broadly, compared with existing analog network though, at the time of transition from analog to digital system, no rapid improvement of transmission performance may not be possible. Thus, for ensuring desired transmission performance during the transition period, guidelines are as under.

1) Objective values set forth in "Fundamental Plan 1985 (draft) for the Telephone Network in Indonesia" be achieved as much as possible.

2) Quality of non-telephone services, such as facsimile and data communication, be not lower than by existing analog network.

Transmission plan objectives based on CCITT recommendations, PERUMTEL standards and results of this study are as under.

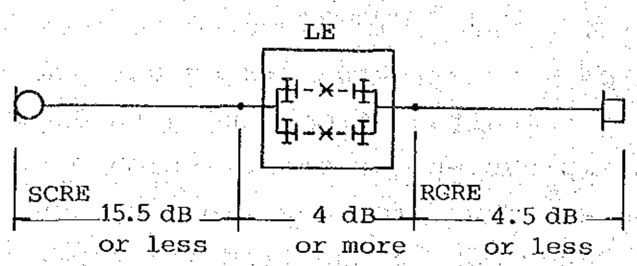
(1) Reference Equivalent (CRE)

1) Local System CRE

- Sending CRE (SCRE) be not over 15.5 dB.
- Receiving CRE (RCRE) be not over 4.5 dB.

- CRE between originating and terminating analog 2-wire points of digital type local switches be 4 dB or better.

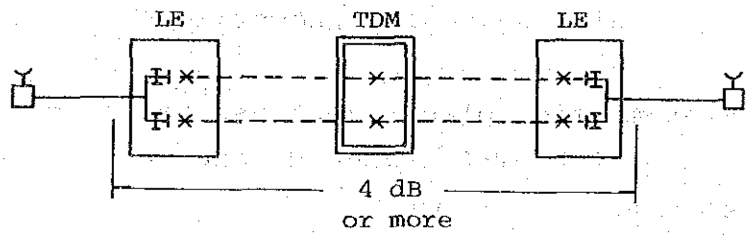
The foregoing CRE arrangement is illustrated below.

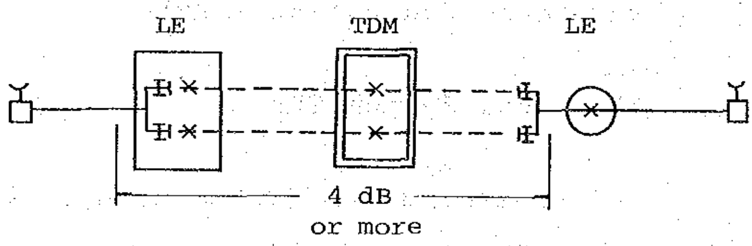


2) CRE of Local Junction Connection

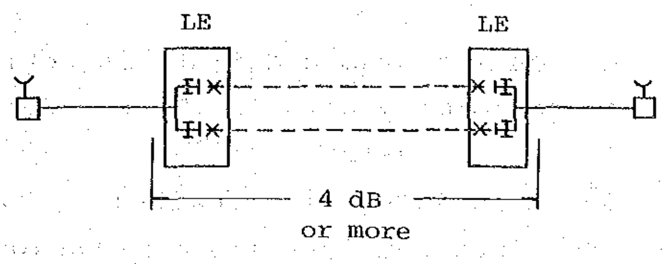
Local Junction CRE objectives are as illustrated below.

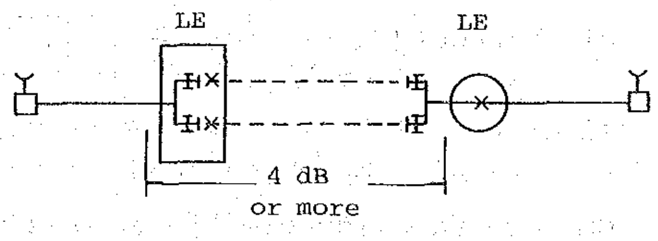
- Tandem Route





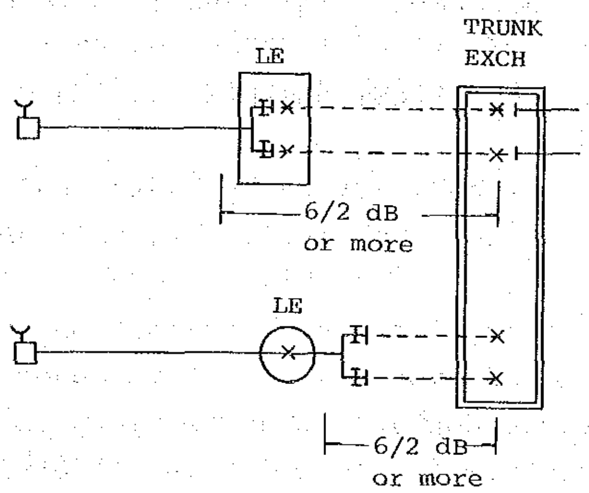
- Through Route





3) CRE of Long Distance Connection Call Connection

CRE of long distance call connection is illustrated below.



(2) Stability

National system stability objectives are as under in conformity with CCITT Rec. G.122.

1) Mean value of transmission loss in transmission route a-t-b be (10 + n) dB or better.

2) Standard deviation be $\sqrt{6.25 + 4n}$ dB.

(3) Echo

Concerning allowable limits of echo, CCITT recommends long term objective and short term objective as under.

1) Long term objective

Probability of encountering echo exceeding allowable limits be less than 1%.

2) Short term objective

Probability of encountering echo exceeding allowable limits be less than 10%.

At initial stage of transition from analog to digital system, short term objective shown above should apply. To attain long term objective, improvement of echo balance return loss of digital switching equipment is necessary, besides utilization of echo controller. For mean value of the said echo balance return loss, 16 dB is desirable.

4-5 Circuit Calculation

4-5-1 Overview

For the number of circuits required in local network, calculation is made for inter-local exchange junctions, SLDD junctions and special numbers (10X and 11X) circuits according to categories of calls.

For calculation, different formulas are used, depending upon the type of switching system (e.g., full-availability switching system or limited-availability switching system) wherein to accommodate circuits, as well as the types of circuits (high usage circuits or final circuits).

In this study, for calculation of final circuits to be accommodated in step-by-step switching equipment (limited-availability switching system), O'Dell experimental formula is used and, for calculation of final circuits to be accommodated in full-availability switching equipment, Erlang B formula is used.

For calculation of high usage circuits with alternate route, theory of alternative trunking described in CCITT Manual "General Network Planning", Chapter 10, is applied.

All the foregoing is to realize local network wherein switching and transmission costs are balanced and which can operate at high efficiency.

4-5-2 Calculation Formula

(1) O'Dell Experimental Formula

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

where

Aij: Traffic offered to Exchange j from Exchange i (Erl.)

Ao: Traffic which can be carried by circuit group whereof availability is <u>no</u> which given grade of service is E. (Erl.)

<u>no</u>: Availability of EMD selector group

E: Grade of service

Therefore, the number of circuits required can be obtained by the following equation:

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

(2) Theory of Alternative Trunking

A well known fact is that economy of local network can be improved by means of optimum alternative routing. CCITT Manual "General Network Planning", Chapter 10, Figures 5 - 28 (x), explains with simplified example of alternative routing. Traffic from Exchange i to Exchange j is carried by direct circuit group i - j. When direct circuits are wholly occupied, overflow traffic is carried by alternative circuit group i - T - j which is via tandem exchange T. In this case, direct circuits are called high usage circuits which carry the most part of traffic, and alternative circuits are called final circuits or tandem circuits.

Alternative routing advantage is that because traffic between two exchanges are divided into two groups, one to be carried via high usage circuits and the other via tandem circuits, the whole network economy can be raised to much higher than when all traffic is carried by direct circuits.

Calculation formulas that appear below are commonly used in computer aided network design. In this case, network model, composed of originating exchange i, terminating exchange j, tandem exchange K and junction circuits that interconnects all these exchanges, is employed.

1) High Usage Circuit

The number of high usage circuits required can be obtained by the following equation:

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

where

Aij: Traffic offered to Exchange j from Exchange i (Erl.)

E: Grade of service

εij: Cost ratio

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

where Bij, Bik and Bkj respectively indicate incremented cost for each additional circuit between exchanges concerned.

2) Tandem Circuit

Mean value Pij and variance Vij of overflow traffic from each high usage circuit group are expressed as under.

$$Pij = Aij \times E(nij, Aij)$$

$$Vij = Pij \left[1 - Pij + \frac{Aij}{nij + 1 + Pij - Aij} \right]$$

Mean value M and variance V of traffic offered tandem circuit are expressed as under.

$$Mik = \sum_{j} Pij, \quad Vik = \sum_{j} Vij$$

$$Mkj = \sum_{i} Pij, \quad Vij = \sum_{i} Vij$$

Therefore, equivalent random traffic A* and equivalent number of circuits n* of tandem circuit are as under.

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

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

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

Therefore, the number of tandem circuits required is as under.

$$A^* \times E(n^* + m, A^*) = E_0 \times M$$

where E_0 indicates grade of service for tandem circuit.

4-5-3 Calculation Formula Applications

In this study, calculation formula applications are decided as under.

(1) O'Dell Experimental Formula

1) To local junctions from step-by-step exchanges (EMD and UR-49A)

2) To intra-office circuits of step-by-step exchanges

(2) Alternative Routing Theoretical Formula

1) To local junctions from common control analog exchanges to newly established digital exchanges

2) To local junctions from newly established digital exchanges to all analog exchanges

3) To local junctions between newly established digital exchanges

(3) Erlang's Loss Formula

1) To intra-office circuits of common control analog exchanges and newly established digital exchanges

2) To local junctions from common control analog exchanges to all analog exchanges

3) To SLDD junctions

4) To special numbers (10X and 11X) circuits

4-5-4 Calculation Parameters

(1) Grade of Service

Grade of service indicates probability of call connections to fail. In Indonesia, the following values by types of calls are used:

	Type of Call	Grade of Service
a)	Local calls	0.01
b)	SLDD calls	0.01
c)	Special number (10X) calls	0.01
d)	Special number (11X) calls	0.005

Note: Suburban calls are superposed on SLDD calls.

(2) Cost Ratio

In alternative routing network design, cost ratio is an important element whereby to determine the number of high usage circuits to be established. Cost ratio presents cost increment ratio for each additional circuit in the case of high usage and tandem circuits.

(3) Minimum Requirement for High Usage Circuits

In this study, assumption is that in case where originating traffic on direct route is, at least, large enough to allow establishing the number of one-way circuits (15 circuits) of one unit of 30 CH PCM system, high usage circuits can be established between two exchanges.

4-5-5 Computer Aided Calculation

Figure 4-5 presents work flow or computer aided calculation used in this study to determine the number of local junctions to be established.

4-5-6 Calculation Results

Calculation results for the number of circuits required are in the undermentioned tables.

(1) Number of Circuits Required by Type of Call (Outgoing Circuits)

1) Table 4-5-1 (1/2): Medan, Semarang and Solo (1988, 1993)

2) Table 4-5-1 (2/2): Medan, Semarang and Solo (1998, 2005)

(2) Number of Local Junctions Required

1) Table 4-5-2 (1/9 - 4/9): Mesan (1988, 1993, 1998, 2005)

2) Table 4-5-2 (5/9 - 8/9): Semarang (1988, 1993, 1998, 2005)

3) Table 4-5-2 (9/9): Solo (1988, 1993, 1998, 2005)

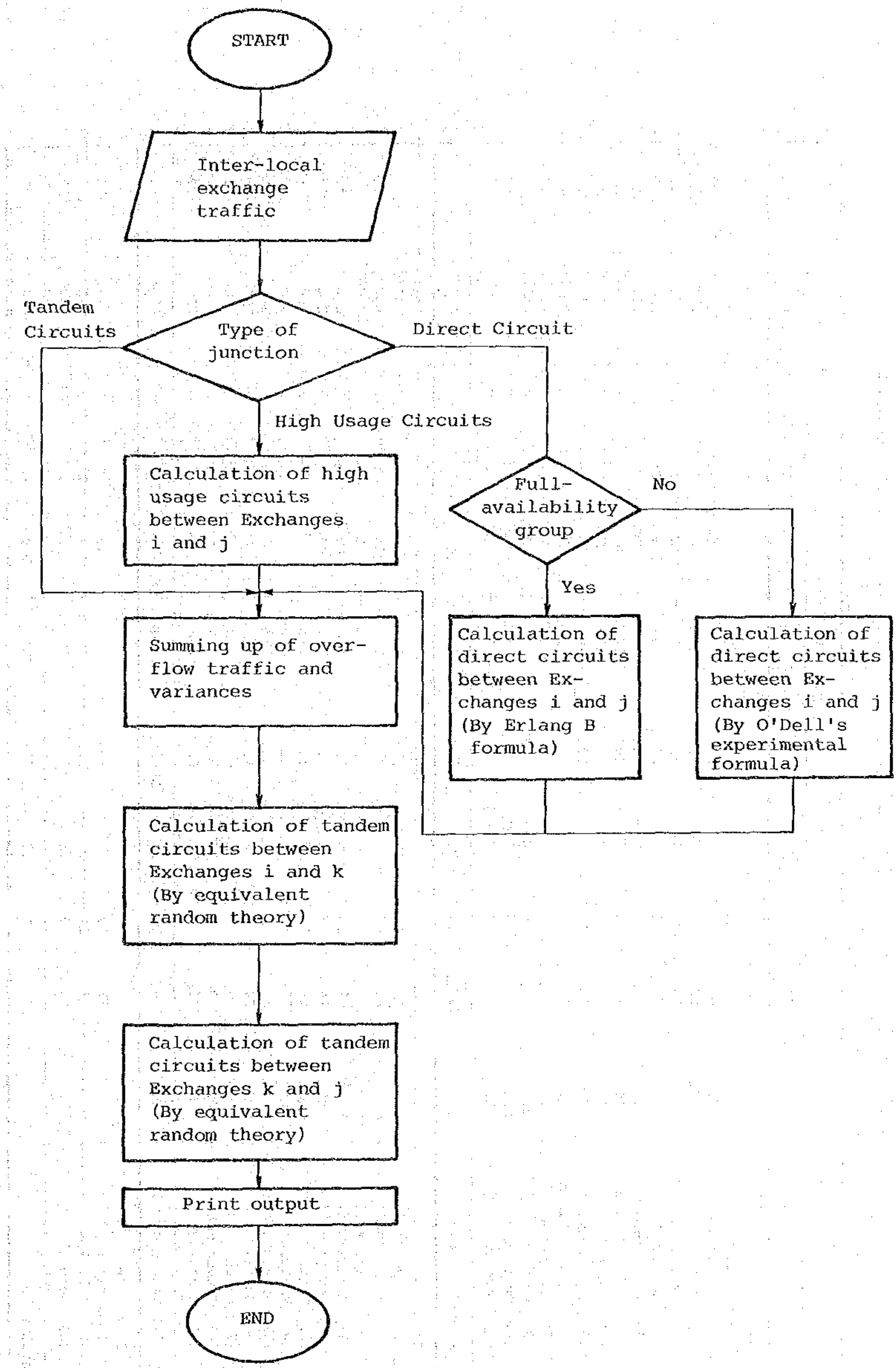


Figure 4-5-1 Work Flow for Calculation of Circuits Required

Table 4-5-1 (1/2) Junction Circuit Requirements Oneway

Exchange	Type	1988 SLDD	1988 10X	1988 11X	1988 Local	1988 Total	1993 SLDD	1993 10X	1993 11X	1993 Local	1993 Total
1. Medan											
(1) Centrum I	UR49A	46	14	7	371	438	0	0	0	0	0
Centrum II	ARF	41	13	6	244	304	50	15	8	312	385
Centrum III	MC10C	52	15	7	319	393	67	19	10	435	531
Centrum IV	MC10	52	15	7	315	389	67	19	10	435	531
Centrum V	DIG	52	15	7	337	411	106	28	14	708	856
(2) Suka Ramai	DIG	57	17	8	360	442	75	21	10	501	607
(3) Pulau Burayan	DIG	43	14	7	283	347	62	17	8	419	506
(4) Padang Bulan	DIG	16	7	4	88	115	22	9	5	155	191
(5) Cinta Damai	DIG	35	11	6	208	260	47	14	8	316	385
(6) Simpang Limun	DIG	23	9	5	147	184	31	10	5	201	247
(7) Tanjung Mulia	DIG	17	7	4	83	111	24	8	5	215	252
(8) Belawan	DIG	16	4	4	76	100	18	7	4	83	112
(9) Tuntungan	DIG	0	0	0	0	0	0	0	0	0	0
(10) Labuhan	DIG	0	0	0	33	33	0	0	0	50	50
Total Medan		450	141	72	2,864	3,527	569	167	87	3,830	4,653
2. Semarang											
(1) Semarang I	EMD	96	19	10	833	958	98	19	10	852	979
Semarang IA	DIG	69	15	8	418	510	109	21	10	644	784
Semarang IB	DIG	0	0	0	0	0	0	0	0	0	0
(2) Semarang II	MC10C	61	14	8	355	438	65	14	8	372	459
Semarang II	DIG	24	7	4	136	171	44	11	6	256	317
(3) Tugu	DIG	54	13	7	319	393	71	16	8	434	529
(4) Majapahit	DIG	37	10	5	207	259	55	12	6	311	384
(5) Banyumanik	DIG	54	12	7	310	383	61	14	8	363	446
(6) Genuk	DIG	24	7	4	120	155	36	9	5	199	249
(7) Mijen	DIG	0	0	0	0	0	0	0	0	0	0
(8) Genung Pati	DIG	0	0	0	0	0	0	0	0	0	0
(9) Mang Kang	DIG	25	7	4	127	163	35	9	5	189	238
Total Semarang		444	104	57	2,825	3,430	574	125	66	3,620	4,385
3. Solo											
(1) Solo I	RF	53	12	7	267	339	38	10	6	179	233
Solo I	DIG	47	11	6	323	387	78	17	9	383	487
(2) Solo II	DIG	30	8	6	146	190	83	18	10	402	513
Total Solo		130	31	19	736	916	199	45	25	964	1,233

SLDD(B=0.01), 10X(B=0.01), 11X(B=0.01), Local(B=0.01)

Table 4-5-1 (2/2) Junction Circuit Requirements Oneway

Exchange	Type	1988					2005				
		SLDD	10X	11X	Local	Total	SLDD	10X	11X	Local	Total
1. Medan											
(1) Centrum I	UR49A	0	0	0	0	0	0	0	0	0	0
Centrum II	ARF	53	14	8	318	393	57	15	8	315	395
Centrum III	MC10C	71	19	10	450	550	77	20	10	448	555
Centrum IV	MC10	71	19	10	450	550	77	20	10	448	555
Centrum V	DIG	183	43	20	1,140	1,386	260	60	25	1,532	1,877
(2) Suka Ramai	DIG	125	32	13	763	933	202	45	18	1,203	1,468
(3) Pulau Burayan	DIG	95	26	13	627	761	168	42	18	1,037	1,265
(4) Padang Bulan	DIG	41	13	7	281	342	65	21	10	455	551
(5) Cinta Damai	DIG	81	22	11	537	651	132	35	17	834	1,018
(6) Simpang Limun	DIG	59	17	8	388	472	116	32	15	728	891
(7) Tanjung Mulia	DIG	39	12	7	217	275	86	23	12	534	655
(8) Belawan	DIG	25	9	5	126	165	32	10	6	174	222
(9) Tuntungan	DIG	13	6	4	66	89	51	15	8	314	388
(10) Labuhan	DIG	18	7	4	67	96	42	14	8	244	308
Total Medan		874	239	120	5,430	6,663	1,365	352	165	8,266	10,148
2. Semarang											
(1) Semarang I	EMD	0	0	0	0	0	0	0	0	0	0
Semarang IA	DIG	270	47	20	1,514	1,851	345	56	23	1,917	2,341
Semarang IB	DIG	0	0	0	0	0	60	13	7	343	423
(2) Semarang II	MC10C	68	14	8	376	466	70	14	8	392	484
Semarang II	DIG	82	16	9	467	574	141	25	13	800	979
(3) Tugu	DIG	100	22	11	653	786	141	31	14	929	1,115
(4) Majapahit	DIG	104	21	11	584	720	165	31	15	931	1,142
(5) Banyumanik	DIG	75	15	7	498	595	98	18	9	710	835
(6) Genuk	DIG	76	16	8	429	529	130	25	11	738	904
(7) Mijen	DIG	8	3	2	25	38	12	4	3	42	61
(8) Genung Pati	DIG	12	4	3	40	59	20	6	4	79	109
(9) Mang Kang	DIG	63	13	7	363	446	93	18	9	554	674
Total Semarang		858	171	86	4,949	6,064	1,275	241	116	7,435	9,067
3. Solo											
(1) Solo I	RF	38	10	6	177	231	0	0	0	0	0
Solo I	DIG	109	23	11	526	669	176	35	15	841	1,067
(2) Solo II	DIG	130	26	14	636	806	181	34	17	856	1,088
Total Solo		277	59	31	1,339	1,706	357	69	32	1,697	2,155

SLDD(B=0.01), 10X(B=0.01), 11X(B=0.01), Local(B=0.01)

Table 4-5-2 (1/9) Local Junction Circuit Requirements in Medan (1988)

From \ To			EX.1	EX.2	EX.3	EX.4	EX.5	EX.6	EX.7	EX.8	EX.9	EX.10	EX.11	EX.12	EX.13	EX.14	TDM	Total O/G
EX.1	Centrum I	(A)	0	0	0	0	0	53	35	0	29	0	0	0	0	0	254	371
Ex.2	Centrum II	(A)	31	28	35	35	29	31	23	0	17	0	0	0	0	0	46	244
Ex.3	Centrum III	(A)	39	35	44	44	44	41	31	0	23	15	0	0	0	0	42	319
Ex.4	Centrum IV	(A)	39	35	44	44	38	41	31	0	23	15	0	0	0	0	44	315
Ex.5	Centrum V	(D)	39	35	44	44	44	48	37	15	29	17	0	0	0	0	24	337
Ex.6	Suka Ramai	(D)	36	31	41	41	48	55	41	0	32	24	0	0	0	0	47	360
Ex.7	Pulau Brayan	(D)	22	26	35	25	41	33	37	0	28	16	0	0	0	0	42	283
Ex.8	Padang Bulan	(D)	0	0	0	0	0	0	0	7	0	0	0	0	0	0	81	88
Ex.9	Cinta Damai	(D)	20	18	23	23	26	32	22	0	21	0	0	0	0	0	43	208
Ex.10	Simpang Limun	(D)	0	0	15	15	18	19	0	0	0	12	0	0	0	0	68	147
Ex.11	Tanjung Mulia	(D)	0	0	0	0	0	0	0	0	0	0	7	0	0	0	76	83
Ex.12	Belawan	(D)	0	0	0	0	0	0	0	0	0	0	0	6	0	0	70	76
Ex.13	Tuntungan	(D)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ex.14	Labuhan	(D)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TDM	Medan Tandem	(D)	49	66	72	72	68	48	49	71	39	52	73	65	0	0		675
Total I/C			275	274	353	343	356	401	306	93	241	151	80	71	0	0	837	3,506

* Circuit required for Remote Line Concentrator

Table 4-5-2 (2/9) Local Junction Circuit Requirements in Medan (1993)

From \ To			EX.1	EX.2	EX.3	EX.4	EX.5	EX.6	EX.7	EX.8	EX.9	EX.10	EX.11	EX.12	EX.13	EX.14	TDM	Total O/G
EX.1	Centrum I	(A)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ex.2	Centrum II	(A)	0	22	29	29	68	41	32	0	27	19	0	0	0	0	51	318
Ex.3	Centrum III	(A)	0	29	38	38	93	57	44	19	37	26	15	0	0	0	54	450
Ex.4	Centrum IV	(A)	0	29	38	38	93	57	44	19	37	26	15	0	0	0	54	450
Ex.5	Centrum V	(D)	0	68	93	93	242	164	128	58	110	79	42	23	0	0	40	1,140
Ex.6	Suka Ramai	(D)	0	41	58	58	165	118	90	42	77	57	10	11	0	0	41	768
Ex.7	Pulau Brayan	(D)	0	32	45	45	129	90	74	29	62	45	25	0	0	13	38	627
Ex.8	Padang Bulan	(D)	0	0	19	19	59	42	29	18	30	19	0	0	0	0	46	281
Ex.9	Cinta Damai	(D)	0	27	38	38	111	78	62	30	55	39	20	0	0	0	39	537
Ex.10	Simpang Limun	(D)	0	19	26	26	80	58	45	23	35	31	0	0	0	0	45	388
Ex.11	Tanjung Mulia	(D)	0	0	0	0	43	29	29	0	20	0	14	0	0	0	82	217
Ex.12	Belawan	(D)	0	0	0	0	0	24	16	0	0	0	0	7	0	0	79	126
Ex.13	Tuntungan	(D)	0	0	0	0	0	0	0	0	0	0	0	0	4	0	62	66
Ex.14	Labuhan	(D)	0	0	0	0	0	0	0	0	0	0	0	5	0	4	58	67
TDM	Medan Tandem	(D)	0	53	54	54	28	42	45	45	42	44	81	76	61	64		689
Total I/C			0	320	438	438	1,111	800	638	283	532	385	222	122	65	81	689	6,124

Table 4-5-2 (3/9) Local Junction Circuit Requirements in Medan (1998)

From \ To			EX.1	EX.2	EX.3	EX.4	EX.5	EX.6	EX.7	EX.8	EX.9	EX.10	EX.11	EX.12	EX.13	EX.14	TDM	Total O/G
EX.1	Centrum I	(A)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ex.2	Centrum II	(A)	0	30	39	39	61	37	30	0	22	0	0	0	0	0	54	312
Ex.3	Centrum III	(A)	0	39	53	53	83	52	42	15	31	19	15	0	0	0	33	435
Ex.4	Centrum IV	(A)	0	39	53	53	83	52	42	15	31	19	15	0	0	0	33	435
Ex.5	Centrum V	(D)	0	61	83	83	132	93	77	31	59	39	27	0	0	0	23	708
Ex.6	Suka Ramai	(D)	0	37	52	52	94	70	56	20	39	29	19	0	0	0	33	501
Ex.7	Pulau Brayan	(D)	0	31	43	43	78	56	49	16	37	20	18	0	0	0	28	419
Ex.8	Padang Bulan	(D)	0	0	15	15	32	20	16	10	0	0	0	0	0	0	47	155
Ex.9	Cinta Damai	(D)	0	23	32	32	60	44	37	0	30	15	0	0	0	0	43	316
Ex.10	Simpang Limun	(D)	0	0	19	19	39	30	20	0	15	14	0	0	0	0	45	201
Ex.11	Tanjung Mulia	(D)	0	0	15	15	28	20	22	0	0	0	11	0	0	50*	54	215
Ex.12	Belawan	(D)	0	0	0	0	0	0	0	0	0	0	0	6	0	0	77	83
Ex.13	Tuntungan	(D)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ex.14	Labuhan	(D)	0	0	0	0	0	0	0	0	0	0	50*	0	0	0	0	50
TDM	Medan Tandem	(D)	0	54	34	34	24	31	29	47	48	43	52	74	0	0		470
Total I/C			0	314	438	438	714	505	420	154	312	198	207	80	0	50	470	4,300

* Circuit required for Remote Line Concentrator

Table 4-5-2 (4/9) Local Junction Circuit Requirements in Medan (2005)

From \ To			EX.1	EX.2	EX.3	EX.4	EX.5	EX.6	EX.7	EX.8	EX.9	EX.10	EX.11	EX.12	EX.13	EX.14	TDM	Total O/G
EX.1	Centrum I	(A)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ex.2	Centrum II	(A)	0	16	21	21	52	42	36	15	28	24	16	0	0	0	44	315
Ex.3	Centrum III	(A)	0	21	28	28	85	66	50	20	40	34	23	0	0	0	53	448
Ex.4	Centrum IV	(A)	0	21	28	28	85	66	50	20	40	34	23	0	0	0	53	448
Ex.5	Centrum V	(D)	0	62	85	85	289	223	189	81	152	132	95	27	58	30	24	1,532
Ex.6	Suka Ramai	(D)	0	43	60	60	223	182	149	65	120	107	76	21	47	0	50	1,203
Ex.7	Pulau Brayan	(D)	0	36	50	50	190	150	134	56	104	90	67	20	35	28	27	1,037
Ex.8	Padang Bulan	(D)	0	15	21	21	82	66	57	28	47	41	24	20	0	0	33	455
Ex.9	Cinta Damai	(D)	0	28	40	40	153	121	104	47	87	74	48	0	34	21	37	834
Ex.10	Simpang Limun	(D)	0	24	34	34	133	108	91	41	74	68	40	0	26	17	38	728
Ex.11	Tanjung Mulia	(D)	0	16	23	23	97	71	68	24	49	40	38	15	16	19	35	534
Ex.12	Belawan	(D)	0	0	0	0	28	22	20	0	15	0	0	8	0	9	72	174
Ex.13	Tuntungan	(D)	0	0	0	0	54	48	35	18	30	31	16	0	16	0	66	314
Ex.14	Labuhan	(D)	0	0	0	0	40	31	29	0	22	18	20	9	0	11	64	244
TDM	Medan Tandem	(D)	0	45	57	57	21	25	28	35	28	36	38	74	60	95		599
Total I/C			0	327	447	447	1,532	1,221	1,040	450	836	729	524	194	292	230	596	8,865

Table 4-5-2 (5/9) Local Junction Circuit Requirements in Semarang (1988)

From \ To			EX.1	EX.2	EX.3	EX.4	EX.5	EX.6	EX.7	EX.8	EX.9	EX.10	EX.11	EX.12	TDM	Total O/G
EX.1	Semarang I	(A)	196	137	0	0	0	0	66	99	38	0	0	0	297	833
Ex.2	Semarang IA	(D)	89	65	0	51	23	50	35	49	22	0	0	17	17	418
Ex.3	Semarang IB	(D)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ex.4	Semarang II	(A)	80	51	0	54	17	39	26	39	0	0	0	0	49	355
Ex.5	Semarang II	(D)	24	23	0	17	10	15	0	18	0	0	0	0	29	136
Ex.6	Tugu	(D)	61	51	0	39	15	43	23	35	0	0	0	19	33	319
Ex.7	Majapahit	(D)	40	24	0	26	0	23	21	28	0	0	0	0	45	207
Ex.8	Banyumanik	(D)	59	50	0	39	15	35	25	42	0	0	0	0	45	310
Ex.9	Genuk	(D)	23	19	0	15	0	0	0	0	10	0	0	0	53	120
Ex.10	Mijen	(D)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ex.11	Gunung Pati	(D)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ex.12	Mang Kang	(D)	23	18	0	15	0	16	0	0	0	0	0	10	45	127
TDM	Semarang Tandem	(D)	32	23	0	94	50	88	37	37	62	0	0	75	0	498
Total I/C			627	461	0	350	130	309	233	347	132	0	0	121	613	3,323

Table 4-5-2 (6/9) Local Junction Circuit Requirements in Semarang (1993)

From \ To			EX.1	EX.2	EX.3	EX.4	EX.5	EX.6	EX.7	EX.8	EX.9	EX.10	EX.11	EX.12	TDM	Total O/G
EX.1	Semarang I	(A)	156	176	0	0	0	0	77	87	47	0	0	0	309	852
Ex.2	Semarang IA	(D)	112	125	0	65	49	81	60	66	32	0	0	32	22	644
Ex.3	Semarang IB	(D)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ex.4	Semarang II	(A)	65	66	0	45	26	42	30	34	18	0	0	17	29	372
Ex.5	Semarang II	(D)	37	49	0	26	22	34	26	28	0	0	0	0	34	256
Ex.6	Tugu	(D)	66	82	0	42	34	58	35	40	23	0	0	27	27	434
Ex.7	Majapahit	(D)	47	47	0	31	26	35	33	35	16	0	0	0	41	311
Ex.8	Banyumanik	(D)	51	67	0	35	29	41	35	41	23	0	0	18	23	363
Ex.9	Genuk	(D)	29	40	0	18	0	21	21	18	15	0	0	0	37	199
Ex.10	Mijen	(D)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ex.11	Gunung Pati	(D)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ex.12	Mang Kang	(D)	27	33	0	17	0	28	0	18	0	0	0	15	51	189
TDM	Semarang Tandem	(D)	34	27	0	82	68	82	28	19	35	0	0	72	0	447
Total I/C			624	712	0	361	254	422	345	386	209	0	0	181	573	4,067

Table 4-5-2 (7/9) Local Junction Circuit Requirements in Semarang (1998)

From \ To			EX.1	EX.2	EX.3	EX.4	EX.5	EX.6	EX.7	EX.8	EX.9	EX.10	EX.11	EX.12	TDM	Total O/G
EX.1	Semarang I	(A)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ex.2	Semarang IA	(D)	0	505	0	119	143	192	179	136	131	0	0	109	0	1,514
Ex.3	Semarang IB	(D)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ex.4	Semarang II	(A)	0	119	0	33	34	42	40	30	28	0	0	22	28	376
Ex.5	Semarang II	(D)	0	144	0	34	46	60	56	44	37	0	0	30	16	467
Ex.6	Tugu	(D)	0	195	0	43	60	83	74	58	48	25	0	48	19	653
Ex.7	Majapahit	(D)	0	162	0	41	56	68	74	55	47	0	0	36	45	584
Ex.8	Banyumanik	(D)	0	140	0	31	44	59	55	46	35	0	40	30	18	498
Ex.9	Genuk	(D)	0	133	0	28	42	48	53	35	41	0	0	26	23	429
Ex.10	Mijen	(D)	0	0	0	0	0	25	0	0	0	0	0	0	0	25
Ex.11	Gunung Pati	(D)	0	0	0	0	0	0	0	40	0	0	0	0	0	40
Ex.12	Mang Kang	(D)	0	112	0	23	31	48	37	30	26	0	0	31	25	363
TDM	Semarang Tandem	(D)	0	38	0	27	15	24	18	18	27	0	0	20	0	187
Total I/C			0	1,548	0	379	471	649	586	492	420	25	40	352	174	5,136

Table 4-5-2 (8/9) Local Junction Circuit Requirements in Semarang (2005)

From \ To			EX.1	EX.2	EX.3	EX.4	EX.5	EX.6	EX.7	EX.8	EX.9	EX.10	EX.11	EX.12	TDM	Total O/G
EX.1	Semarang I	(A)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ex.2	Semarang IA	(D)	0	541	90	104	213	231	244	160	192	0	0	142	0	1,917
Ex.3	Semarang IB	(D)	0	90	19	15	39	42	44	25	29	0	0	22	18	343
Ex.4	Semarang II	(A)	0	104	16	25	46	41	45	29	34	0	0	24	28	392
Ex.5	Semarang II	(D)	0	214	39	46	91	97	102	69	81	0	0	61	0	800
Ex.6	Tugu	(D)	0	234	42	42	98	111	112	76	88	42	0	68	16	929
Ex.7	Majapahit	(D)	0	226	32	45	103	112	125	80	85	0	0	62	51	921
Ex.8	Banyumanik	(D)	0	164	26	30	70	77	81	58	64	0	79	43	18	710
Ex.9	Genuk	(D)	0	195	36	34	82	89	95	57	79	0	0	48	23	738
Ex.10	Mijen	(D)	0	0	0	0	0	42	0	0	0	0	0	0	0	42
Ex.11	Gunung Pati	(D)	0	0	0	0	0	0	0	79	0	0	0	0	0	79
Ex.12	Mang Kang	(D)	0	146	22	25	62	69	62	43	49	0	0	47	29	554
TDM	Semarang Tandem	(D)	0	43	23	28	0	16	22	22	22	0	0	29	0	205
Total I/C			0	1,957	345	394	804	927	932	698	723	42	79	546	183	7,630

Table 4-5-2 (9/9) Local Junction Circuit Requirement in Solo

(1988)

From \ To	EX.1	EX.2	EX.3	Total O/G
EX.1 Solo I (A)	112	97	58	267
EX.2 Solo I (D)	97	84	51	232
EX.3 Solo II (D)	59	52	35	146
Total I/C	268	233	144	645

(1993)

From \ To	EX.1	EX.2	EX.3	Total O/G
EX.1 Solo I (A)	35	72	72	179
EX.2 Solo I (D)	72	155	156	383
EX.3 Solo II (D)	73	157	172	402
Total I/C	180	384	400	964

(1998)

From \ To	EX.1	EX.2	EX.3	Total O/G
EX.1 Solo I (A)	26	70	81	177
EX.2 Solo I (D)	70	211	245	526
EX.3 Solo II (D)	81	245	310	636
Total I/C	177	526	636	1,339

(2005)

From \ To	EX.1	EX.2	EX.3	Total O/G
EX.1 Solo I (A)	0	0	0	0
EX.2 Solo I (D)	0	426	415	841
EX.3 Solo II (D)	0	414	442	856
Total I/C	0	840	857	1,697

4-6 Non-Telephone Service Expansion Plan

4-6-1 Service Status Quo

At present, in Indonesia, non-telephone services are mainly telex, leased circuit and telegram services.

For data communication service, trial operation by experimental packet service network called PACSATNET which uses satellite link is being carried out by PERUMTEL. Commercial service details including service tariff, etc. are to be determined after careful study of trial operation results.

4-6-2 Demand Trends

The past growth trends of non-telephone services in Indonesia are in Table 4-6-1.

(1) Telex and Leased Circuit Services

Both telex and leased circuit services record almost the same growth rate. Annual growth rate in recent years is 15% for 1983 and 25% in average for 1974 and after.

(2) Telegram Service

Domestic telegram service also presents high growth rate. During the past 10 years from 1974 to 1983, the number of chargeable words records annual growth by about 9%. The number of chargeable words in 1983 is more than twice the corresponding number in 1974. However, demand for international telegram service draws sharp downcurve. The number of chargeable words in 1983 is one-third the corresponding number in 1974.

4-6-3 Long Term Demand Outlook

(1) From long term viewpoint, strong demand for non-telephone services can be expected not only from government/public offices but from civilian business sources also. This demand upswing reflects steady growth of Indonesian economy. Demand trends for non-telephone services from now forward will be from conventional services to new services, i.e., from telegram to telex services and further to facsimile and data communication services.

(2) For facsimile and data communication services, preparations are being made for practicing on utility basis in the very near future. Demand for these services will record high growth rate at initial stage as was the case with developed countries. PERUMTEL estimates national total of data terminals as of 2000 at about 4,000.

(3) In the field of conventional non-telephone services, domestic telegram service demand is considered to reach the saturation point earlier than telex demand. By reason of demand transfer to new services, demand growth for telex and leased circuit services will slow down. Nevertheless, demand itself is presumed not to mark time before 2005.

4-6-4 Demand Forecast

Demand forecast results for non-voice communication services are in Table 4-6-2 and Table 4-6-3.

In this study, demand forecast for non-telephone services is based on the foregoing long term demand outlook. Out of new services, data communication service is considered to record almost the same growth rate as the telex service growth rate in the past.

4-6-5 Number of Local Junctions Required

With regard to the number of local junctions required for non-telephone services, forecast results are in Figure 4-6-1. Forecast is based on the undermentioned preconditions.

(1) Non-telephone centers to handle non-telephone services be established in Centrum Exchange in Medan, Semarang I Exchange in Semarang and Solo I Exchange in Solo.

(2) Subscriber circuits for data communication, telex and leased circuit services be first connected to nearest exchange MDF via subscriber telephone cables and then extended via local junctions for telephones to non-telephone centers for non-telephone services.

(3) Originating and terminating telegram traffic is of the nature not to be extended to subscriber's premises but to be terminated at gentex exchange. Hence no establishment of local junction for telegram traffic.

(4) Calculation to determine the number of junction lines required for non-telephone services is on 64 Kbit/s base. This means that 20 telex circuits (3.2 Kbit/s) or 5 data circuits (9.6 Kbit/s) correspond to one(1) telephone circuit (64 Kbit/s). For ordinary leased circuits, 9.6 Kbit/s base calculation is made. The number of circuits required shown in Figure 4-6-1 includes spare circuits.

(5) For local junctions for newly established data communication and telex circuits, assumption is that those circuits be connected at nearest telephone exchange to 9.6 or 3.2 Kbit/s rating digital converter; then, to be connected to local junctions for telephones, be converted to digital telephone circuit rating (64 Kbit/s). Local circuits for existing analog telex service area to be connected intact to metallic junction lines for telephones.

4-6-6 Traffic Trend and Forecast

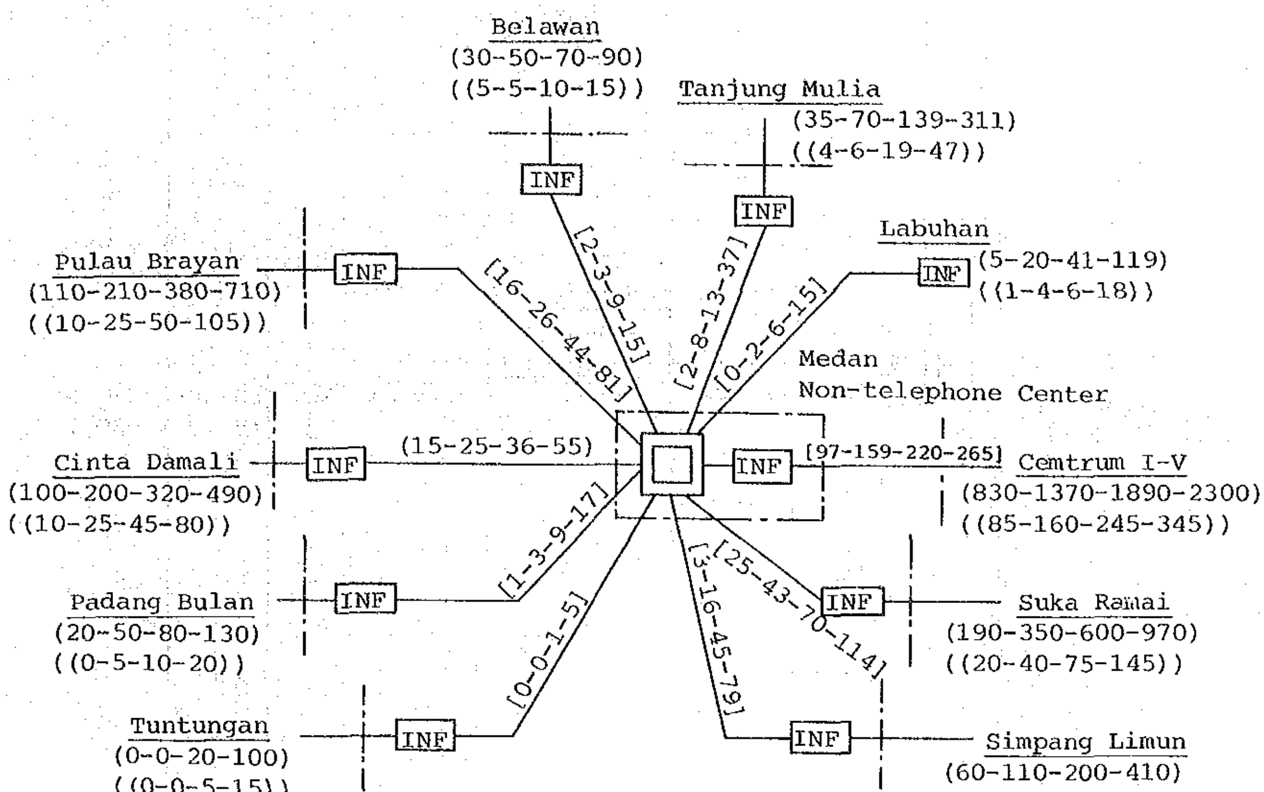
Forecast results for non-telephone traffic are in Table 4-6-4.

(1) Telex

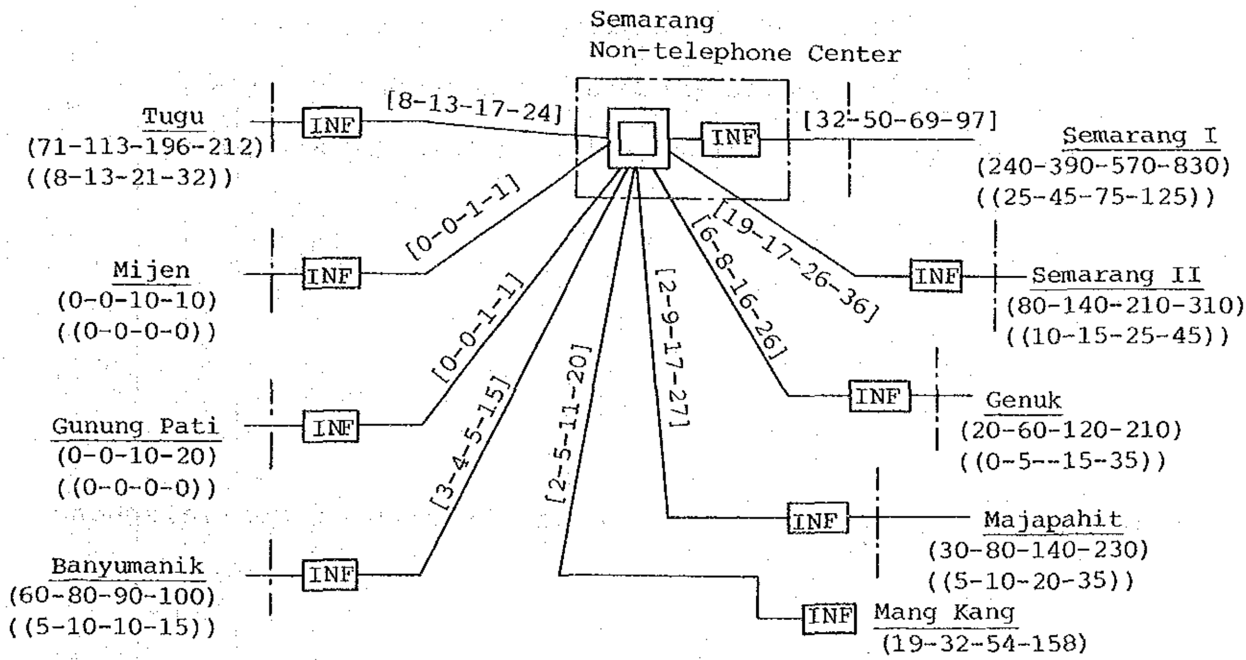
Assumption is that domestic and overseas telex traffic growth rate will be practically compatible with the number of telex circuits growth rate.

(2) Data Communication

At the present stage, reasonable traffic forecast is difficult.

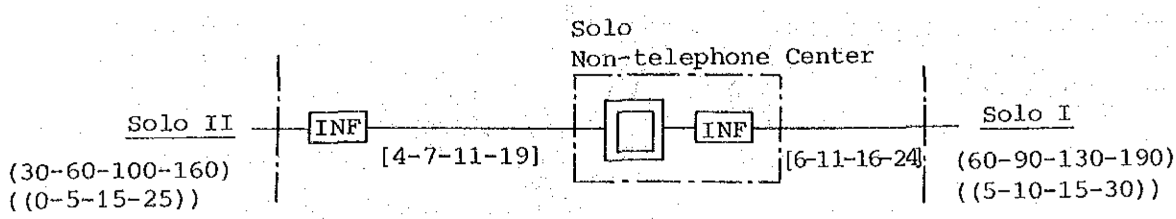


(1: Medan)



(2: Semarang)

Figure 4-6 (1/2) Local and Junction Circuits of Non-Telephone Service



(3: Solo)

(Note)

INF :	Subscriber Line Interface	
( ):	Telex Subscribers	1988-1993-1998-2005
(( )):	Leased and Data	1988-1993-1998-2005
[64 kb/s]:	Digital Junctions	1988-1993-1998-2005

Figure 4-6 (2/2) Local and Junction Circuits of Non-Telephone Service

Table 4-6-1 Historical Growth of Non-Telephone Service Demand in Whole Indonesia

Item	Year										Growth Rate (%)	Remarks
	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983		
1. Telex Lines	1,194	1,571	2,095	2,397	3,200	4,009	5,307	6,740	8,105	9,292	25.6	
(1) Telex subscribers	1,109	1,430	1,857	2,159	2,871	3,612	4,743	6,151	7,429	8,570	25.5	
(2) Gentex, etc.	85	141	238	238	329	397	564	589	676	722	26.8	
2. Leased Circuits	76	105	124	150	172	202	294	355	491	560	24.8	
3. Telegram (10^3 paid word)												
(1) Domestic	113,528	106,355	125,386	134,402	150,103	167,885	190,901	205,372	214,669	240,074	8.7	
(2) Overseas	15,420	14,731	13,243	11,530	9,682	7,930	6,790	5,698	4,548	3,328	(-)18.6	

Table 4-6-2 (1/2) Non-Telephone Demand Forecast

Item / Area	Telex Service								
	1983		1988		1993		1998		2005
Whole Indonesia	8,570 (*1)		17,250		30,400		46,800		70,400
(Growth rate %)		15		12		9		6	
(1) Medan	667 (*2)		1,380		2,430		3,740		5,630
(2) Semarang	250 (*3)		520		910		1,400		2,100
(3) Solo	40 (*3)		90		150		230		350

Item / Area	Leased Circuits								
	1983		1988		1993		1998		2005
Whole Indonesia	560 (*1)		1,130		1,990		3,060		4,600
(Growth rate %)		15		12		9		6	
(1) Medan	50 (*4)		90		160		245		370
(2) Semarang	20 (*4)		35		60		90		140
(3) Solo	5 (*4)		5		10		15		25

Note: *1: Traffic Dalam Angka 1982-1983
*2: Selayang Pandang Witel I Dalam Angka 1984
*3: Data from UTEKGRAP, Witel VI
*4: Estimated

Table 4-6-2 (2/2) Non-Telephone Demand Forecast

Item / Area	Data Service								
	1983		1988		1993		1998		2005
Whole Indonesia	200 (*1)		610		1,520		3,060		6,000
(Growth rate %)		25		20		15		10	
(1) Medan	15		50		120		245		480
(2) Semarang	10		20		45		90		180
(3) Solo	-		-		10		15		30

Note: *1: Estimated

Table 4-6-3 (1/2) Area-by-Area Demand Forecast for Non-Telephone Service

Item	Telex Service				Leased and Data				Note
Local District	1988	1993	1998	2005	1988	1993	1998	2005	
Whole Medan	1,380	2,430	3,740	5,630	140	280	490	850	
Centrum	830	1,370	1,890	2,300	85	160	245	345	
Suka Ramai	190	350	600	970	20	40	75	145	
Pulau Brayan	110	210	380	710	10	25	50	105	
Padang Bulan	20	50	80	130	-	5	10	20	
Cinta Damai	100	200	320	490	10	25	45	80	
Simpang Limun	60	110	200	410	5	10	25	60	
Tanjung Mulia	35	70	139	311	4	6	19	47	
Belawan	30	50	70	90	5	5	10	15	
Tuntungan	0	0	20	100	0	0	5	15	
Labuhan	5	20	41	119	1	4	6	18	

Table 4-6-3 (2/2) Area-by-Area Demand Forecast for Non-Telephone Service

Item	Telex Service				Leased and Data				Note
Local District	1988	1993	1998	2005	1988	1993	1998	2005	
Whole Semarang	520	910	1,400	2,100	55	105	180	320	
Semarang I	240	400	570	830	25	45	75	125	
Semarang II	80	140	210	310	10	15	25	45	
Tugu	70	113	196	212	8	13	21	32	
Majapahit	30	80	140	230	5	10	20	35	
Banyumanik	60	80	90	100	5	10	10	15	
Genuk	20	60	120	210	-	5	15	35	
Mijen	0	0	10	10	-	-	-	-	
Gunung Pati	0	0	10	20	-	-	-	-	
Mang Kang	19	32	54	158	2	7	14	23	
Whole Solo	90	150	230	350	5	15	30	55	
Solo I	60	90	130	190	5	10	15	30	
Solo II	30	60	100	160	-	5	15	25	

Table 4-6-4 (1/2) Historical Growth of Telex Traffic

Item	Telex Traffic								Growth Rate (%)
Year	1973	1974	1975	1976	1977	1978	1979	1980	
1. Domestic No. of Pulse ($x10^6$)	9.9	12.7	17.1	22.9	28.0	35.9	43.3	56.9	28.4
2. International Charged Minutes ($x10^6$)	1.4	1.9	2.6	2.9	3.9	4.5	5.5	6.9	25.6

Table 4-6-4 (2/2) Prospective Growth of Telex Traffic

Item	Telex Traffic								
Year	1983		1988		1993		1998		2005
1. Domestic No. of Pulse (Growth Rate %)	336.4	15	676.6	12	1,192.4	9	1,834.7	6	2,758.7
2. International Charged Minutes (Growth Rate %)	11.0	15	22.1	12	38.9	9	59.9	6	90.1

4-7 Circuit Grouping

Circuit grouping of telephone service and non-telephone service junction circuits by transmission section is in Figure 4-7 (1/6 - 6/6). The undermentioned circuits are excluded from this circuit grouping.

(1) Outgoing/incoming telephone circuits between switching equipment in the same exchange compounds

(2) Outgoing/incoming analog telephone circuits between existing analog switching equipment

(3) Belawan - Centrum II non-telephone circuits

Circuits in item (1) above are included in tie cables or office cables. Circuits in item (2) tend to decrease in one year after another so that existing cables can fully meet circuit demand. Furthermore, from technical and economic viewpoints, digitalization of these circuit is not advisable. Circuits in item (3) are to be accommodated in existing UHF system (frequency division multiplex system).

CENTRUM I — TDM [D] — ⑤ [D]   (j1)   SUKA RAMAI — ⑥ [D]

Circuit	⑤ '93	⑤ '98	⑤ '05	⑥ '93	⑥ '98	⑥ '05
	187	329	446	187	329	446
(TDM)	64	83	75	64	83	75
(11X)	10	13	18	10	13	18
②	74	82	85	74	82	85
③	104	115	126	104	115	126
④	104	115	126	104	115	126
(SLDD)	150	250	404	150	250	404
(10X)	21	32	45	21	32	45
(NT)	43	70	114	43	70	114 A
⑦	112	180	299	112	180	299
⑪	39	39	147	39	39	147
⑫	—	35	43	—	35	43
⑭	—	—	31	—	—	31
⑧	40	84	131	40	84	131
⑨	83	155	241	83	155	241
⑬	—	—	95	—	—	95

CENTRUM I (⑤) → ⑩ and SUKA RAMAI (⑥) → ⑩

Circuit	'93	'98	'05
⑤ → ⑩	78	159	265
(TDM)	88	89	74
(11X)	5	8	15
②	—	38	48
③	38	52	68
④	38	52	68
(SLDD)	62	118	232
(10X)	10	17	32
(NT)	16	45	79
⑧	—	42	82
⑨	30	74	148
⑬	—	—	57
⑦	40	90	181
⑪	—	—	80
⑭	—	—	35
⑥ → ⑩	51	115	215

SIMPANG LIMUN — ⑩ [D]   (j1)

Circuit	'93	'98	'05
⑤	78	159	265
(TDM)	88	89	74
(11X)	5	8	15
②	—	38	48
③	38	52	68
④	38	52	68
(SLDD)	62	118	232
(10X)	10	17	32
(NT)	16	45	79 A
⑧	—	42	82
⑨	30	74	148
⑬	—	—	57
⑦	40	90	181
⑪	—	—	80
⑭	—	—	35
⑥	51	115	215

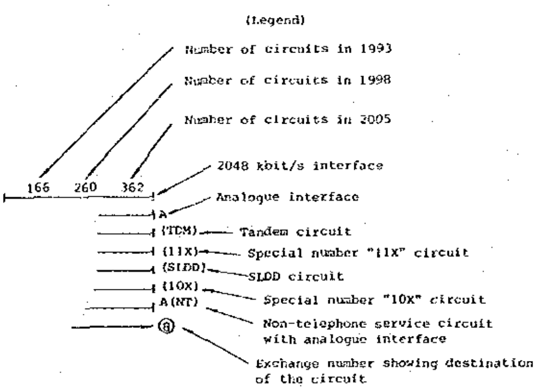


Figure 4-7 (1/6) Circuit Grouping (Medan 1/3)

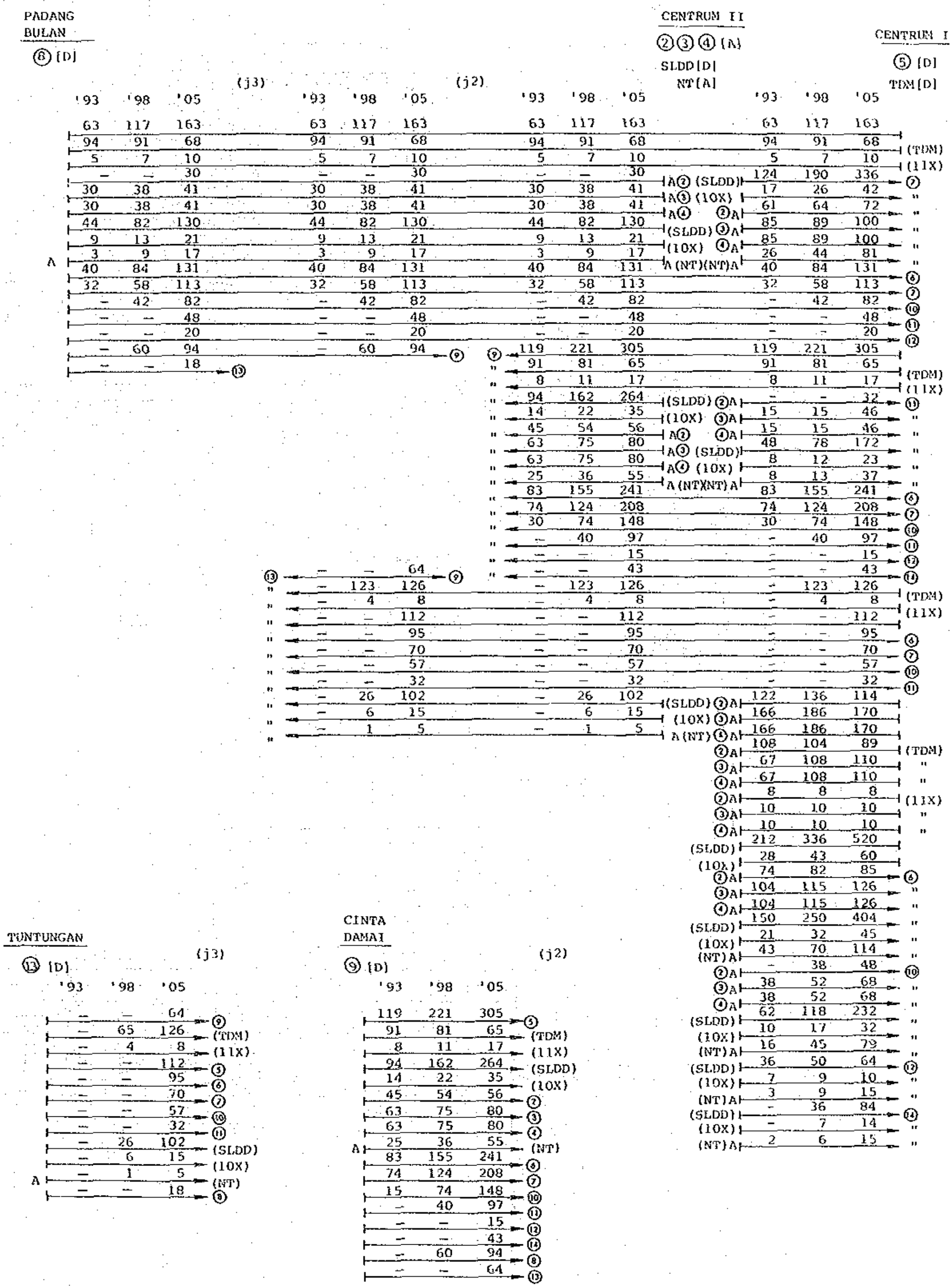


Figure 4-7 (2/6) Circuit Grouping (Medan 2/3)

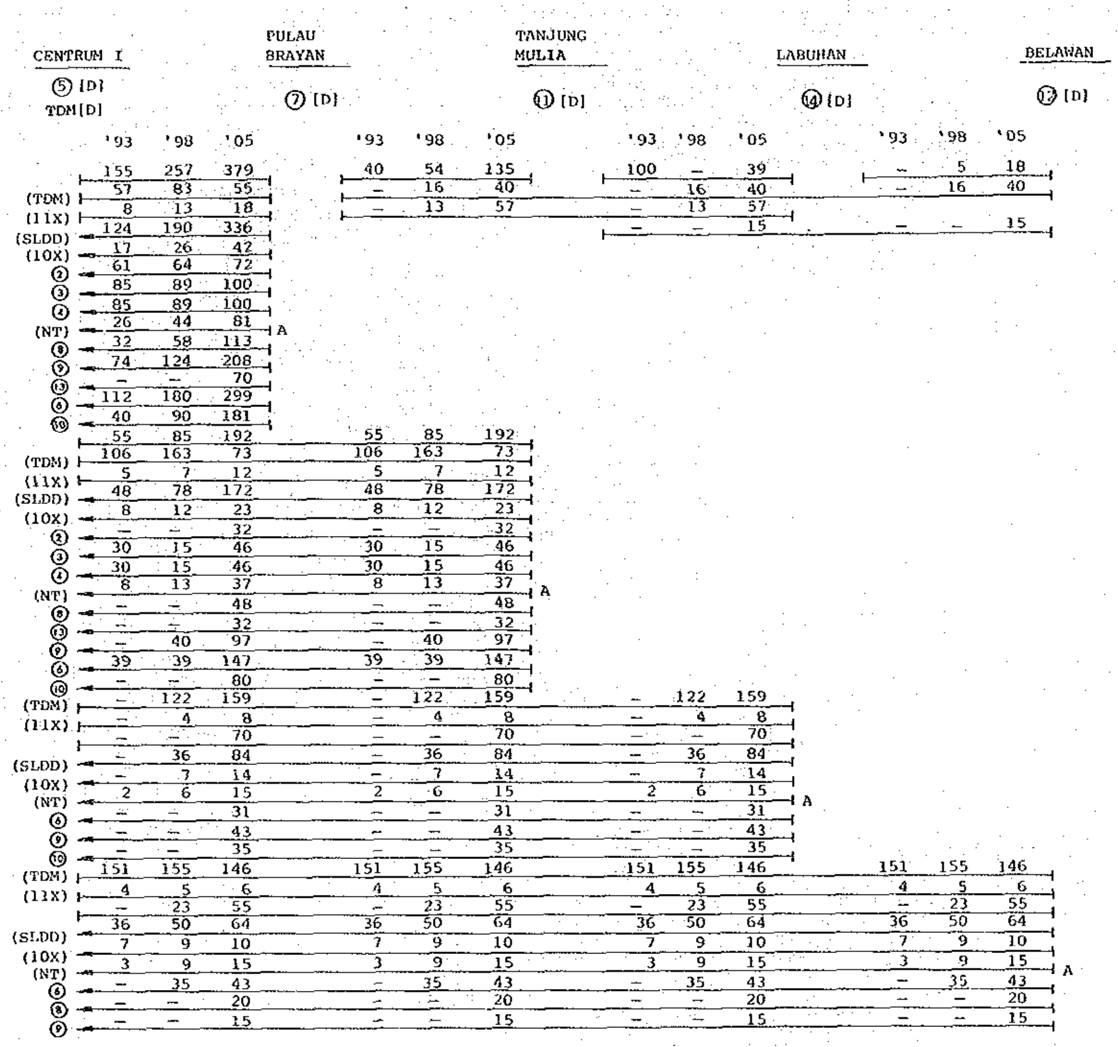


Figure 4-7 (3/6) Circuit Grouping (Medan 3/3)

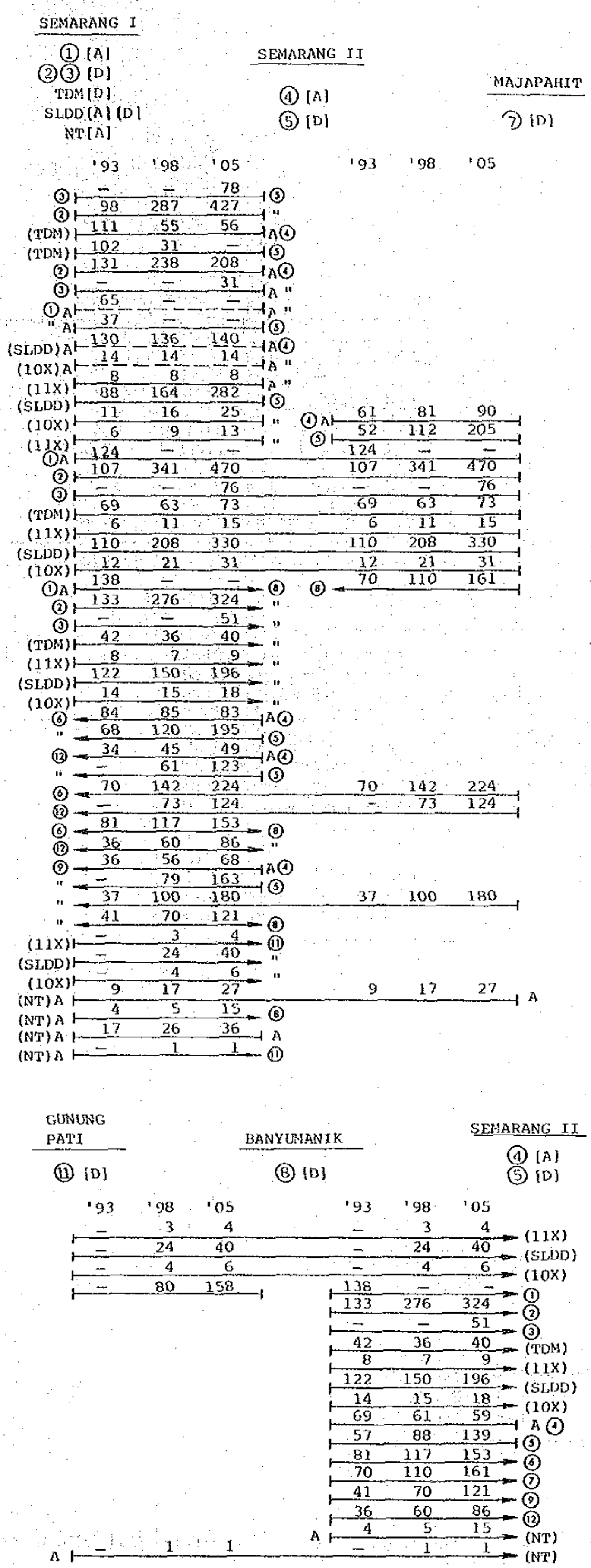
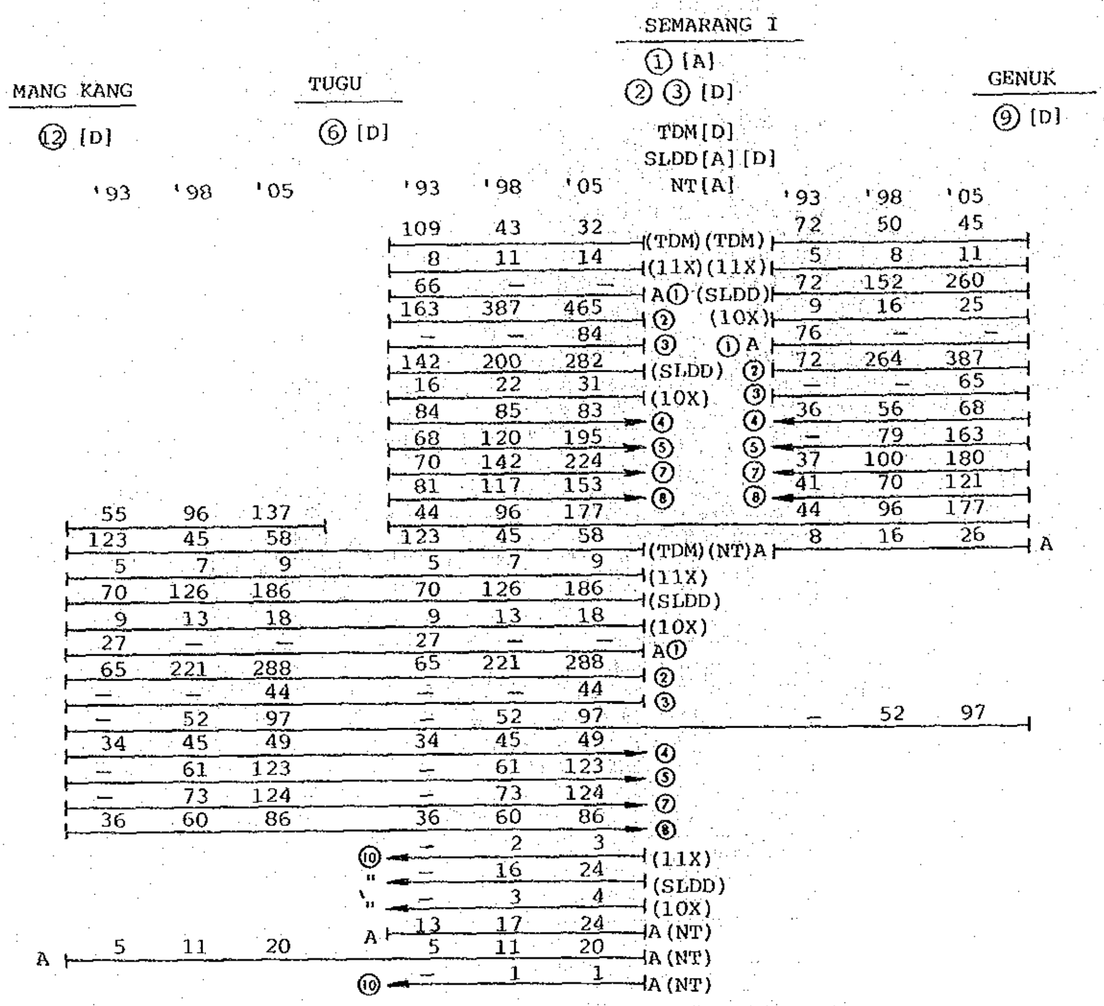


Figure 4-7 (4/6) Circuit Grouping (Semarang 1/2)



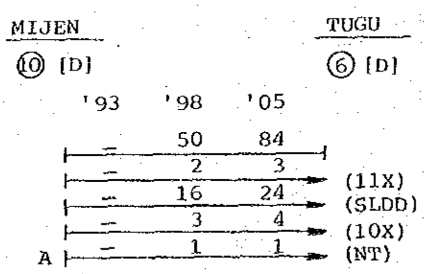


Figure 4-7 (5/6) Circuit Grouping (Semarang 2/2)

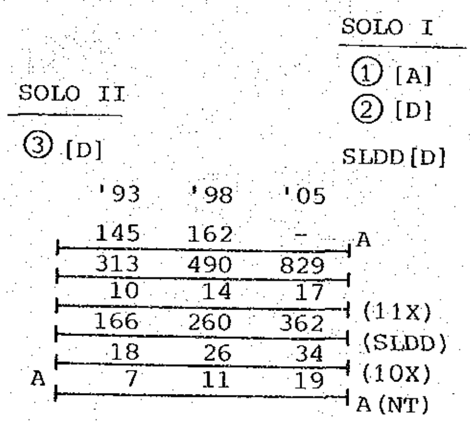


Figure 4-7 (6/6) Circuit Grouping (Solo 1/1)

CHAPTER 5 PROPOSAL ON INSTALLATION PLAN UNDER REPELITA-IV

CHAPTER 5 PROPOSAL ON INSTALLATION PLAN UNDER REPELITA-IV

5-1 Summary

(1) As stated in Chapter 4, Section 4-1, the long term installation plan is to terminate in the year 2005. However, the objective of 100% demand fulfillment is to be attained before that final year, i.e., in 2000. To accomplish this objective, REPELITA-IV Program is identified as the first essential. More precisely, to satisfy strong demand for telephone and non-telephone services in the three objective cities in the years up to 2005, the prerequisite is to realize at least the initial target described in Section 5-2 during REPELITA-IV period.

(2) Installation plan wherewith this study is concerned pertains to outside plant facilities out of all kinds of facilities to be established by REPELITA-IV. Installation plan, this time, comprises subscriber's cable network and junction cable network expansion and establishment of new digital transmission facilities in junction network.

5-2 Telephone Installation Plan

Exchange	JICA Proposed Planning Target (Line units: 10^3)	PERUMTEL's Planning Target (Line units: 10^3)
(1) Medan Area		
Centrum	36.9	45.0
Suka Ramai	10.2	12.0
Pulau Brayan	9.8	11.0
Padang Bulan	4.0	8.0
Cinta Damai	6.0	7.0
Simpang Limun	4.2	7.0
Tanjung Mulia	1.6	3.0
Belawan	1.8	2.0
Labuhan	0.7	-
Total	75.2	95.0
(2) Semarang Area		
Semarang I	16.6	25.4
Semarang II	11.8	15.0
Genuk	2.3	1.0
Tugu	7.0	1.0
Banyumanik	6.8	1.0
Majapahit	5.4	0.6
Mang Kang	2.3	-
Total	52.2	44.0
(3) Solo Area		
Solo I	11.0	13.0
Solo II	8.7	4.0
Total	19.7	17.0

5-3 Non-Telephone Installation Plan

Non-telephone outside plant facilities consist of subscriber's lines and junction cables for connection to non-telephone service center via telephone cables.

Judging from non-telephone service demand size, this study sets aside 3% of each of telephone subscriber's cables and junction cables for non-telephone system facilities.

CHAPTER 6 SUBSCRIBER CABLE NETWORK

CHAPTER 6 SUBSCRIBER CABLE NETWORK

6-1 Design Standards for Subscriber Cable Network and Underground Conduit Facilities

6-1-1 Network Composition

Subscriber cable network composing systems are twofold. They are cross-connecting cabinet system and direct wiring system. In this project, cross-connecting cabinet system is adopted, in principle.

(1) Cross-Connecting Cabinet System

Cross-connecting cabinet system is to install a cross-connecting cabinet in the middle part of subscriber cable network and to connect primary and secondary cables in the cabinet, using jumper wire.

Principal merits of this system are: First, primary cable pairs can be limited to necessary minimum; second, primary and secondary cable sections respectively allow cable expansion on independent basis.

(2) Direct Wiring System

Direct wiring system is for direct primary cable installation from MDF to distribution point. This system is applicable to large scale subscribers whose telephone demand as of the year 2005 exceeds 200 lines.

6-1-2 Cabinet Area Establishment

Cross-connecting cabinet area remains unchanged for a line time as a demand and facilities management unit. Purpose is to realize effective use of outside plant and appropriate plant expansion. Therefore, the cabinet area must be so established that network design, execution and maintenance will in no way be disturbed.

(1) Establishment Method

First, cross-connecting cabinet area contour is chosen, using river, railway or main road as boundary. Then, in consideration of existing facilities, roads, administrative zones and local features, and by so arranging that gross demand as of year 2005 will be 700 lines or thereabouts, the cabinet area is finally determined.

In case where town planning, road planning and related affairs are indeterminate and cabinet area establishment in final form is impossible, not final but temporary cabinet area is established.

For temporary cabinet area, appropriate size is chosen in careful consideration of local conditions, as well as the number of existing subscribers and the number of existing and possible future waiting subscribers.

(2) Cabinet Location

One cross-connecting cabinet is established in one cabinet distribution area. Cabinet location is toward telephone exchange in cabinet distribution area and near manhole. Furthermore, cabinet location must be such that secondary cable can be installed at low cost and must be at such place that no future re-location will be required.

(3) Cabinet Type

Cross-connecting cabinet capacity is for 1,600 cable pairs so as to accommodate 700 lines as estimated demand as of year 2005. Terminal blocks hold capacity for 100 and 200 pairs for both primary and secondary cables. After cable fixing, terminal blocks are filled with compound. In case where stub cable is used, stub cable connection to primary and secondary cables is done in manhole.

(4) Cabinet Number

For the purpose of demand and facilities management, cross-connecting cabinet and cabinet distribution area are given four-digit number. This numbering is in such manner as to facilitate management, e.g., clockwise from north of the exchange, beginning with cabinet nearest to the exchange and extending to farther cabinets from the exchanges, along cable route.

6-1-3 Subscriber Cable

Cable to be used for subscriber lines conforms to PERUMTEL's Standard Cable Specifications. Cable type, pairs and conductor diameter are as under.

(1) Cable Type

1) Primary Cable

Primary cable to be used is, in principle, PE sheathed and insulated, unit quad and jelly filled cable. For cutover of existing air-core type cable, PE sheathed and insulated, unit quadded, air-core type cable is used.

Such primary cable is installed in underground conduit. However, in the cases mentioned below, steel tape armoured cable is to be buried in the ground.

a) In case where cable line re-location is anticipated due to road and/or river improvement work.

b) In case where underground conduit is not appropriate because road planning remains undecided.

2) Secondary Cable

For secondary cable, PE sheathed and insulated, jelly filled, steel tape armoured and quad type cable is used, in principle.

Usually, secondary cable is direct-buried. However, in case where idle conduit is available along underground conduit, secondary cable may be installed in such idle conduit.

In the cases mentioned below, PE sheathed and insulated, quad and self-supporting type aerial cable is used.

a) In case where cable line re-location is anticipated due to river and/or road improvement work.

b) In case where direct burying is not appropriate because road planning remains undecided.

c) In case where area concerned is agricultural area.

(2) Cable Pairs

1) Primary Cable

Number of pairs of primary cable to be used is in Table 6-1. Cable, whereof the number of pairs is in parentheses, is not used in this project under REPELITA-IV.

Table 6-1 Number of Pairs of Primary Cable

Conductor Diameter (mm)	Number of Cable Pairs
0.4	200, 300, 400, 600, 800, 1200, (1500), (1800), (2400)
0.6	200, 300, 400, 600, 800, (1200)
0.8	200, 300, 400, (600)

( ): used in future

2) Secondary Cable

Number of pairs of secondary cable to be used is in Table 6-2.

Table 6-2 Number of Pairs of Secondary Cable

Type of Cable	Conductor Diameter (mm)	Number of Cable Pairs
Direct Buried Cable	0.4	10, 20, 30, 50, 60 80, 100, 200
	0.6	10, 20, 30, 50, 60 80, 100, 200
	0.8	10, 20, 30, 50, 60 80, 100, 200
Aerial Cable	0.6	10, 20, 30, 50, 100
	0.8	10, 20, 30, 50

3) Electric Characteristics

Electric characteristics including D.C. resistance and line attenuation loss (800 Hz) by conductor diameters are in Table 6-3.

Table 6-3 Loop Resistance and Line Attenuation

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
1.0	46	0.66

6-1-4 Conductor Diameter Decision

Cable conductor diameter is decided by two factors, i.e., reference equivalent determined for subscriber system from the viewpoint of transmission performance, and D.C. resistance limit value for switching equipment. Furthermore, conductor diameter thus decided must be economically most desirable.

(1) Reference Equivalent

Reference equivalent for subscriber system in Indonesia is as under.

1) Sending reference equivalent (SCRE) 15.5 dB
(in case where carbon microphone is used: 14.5 dB)

2) Receiving reference equivalent (RCRE) 4.5 dB

(2) D.C. Resistance Limit Value

D.C. resistance limit values by switching equipment types in telephone network of Indonesia are in Table 6-4.

Table 6-4 Maximum Loop Resistance of Switch

Type of Switching System	Maximum Loop Resistance (ohm)	
a) EWSD	1,800	
b) MC-10C	1,500	Note 1
c) EMD	1,500	
d) PC-1000C	1,800	Note 1
e) ARF	1,800	Note 1

Note 1: Telephone set is included.

(3) Combination of Different Conductor Diameters

In consideration of cases where primary cable and secondary cable conductor diameters are combined, economical design is required.

In primary cable section or secondary cable section, combination of different conductor diameters is not practiced. Therefore, in one cross-connecting cabinet area, cable of the same conductor diameter is used, in principle.

(4) Subscriber Cable Distance Limit

Subscriber cable distance limit is determined by limit value of sending reference equivalent (SCRE) of 14.5 dB (in case where telephone is carbon microphone).

When telephone loss of carbon microphone is assumed to be 4 dB, SCRE assigned for subscriber cable becomes

14.5 dB - 4 dB = 10.5 dB

Within this scope, standard cable design is made. However, the arrangement of PBX line is considered in the actual cable design.

Parametric values to be used in cable design are in Table 6-5.

Table 6-5 SCRE and Maximum Length of Subscriber Cable

Conductor Diameter (mm)	SCRE of Cable (dB/km)	Maximum Cable Length (km)
0.4	3.50	3.0
0.6	1.84	5.7
0.8	1.25	8.4

6-1-5 Design for Underground Conduit Facilities

Underground conduit design must be made, placing emphasis on minimum cost, as well as safety, maintenability and working property.

(1) Route Selection

Based on field survey findings and related data including town planning and in all-round consideration of technical requirements pertaining to construction and maintenance, conduit route is selected. The undermentioned items must also be carefully considered.

1) Utilization of Existing Underground Facilities

For the purpose of effective utilization of existing facilities, design is made by methods described below.

a) In case where idle conduit other than spare conduit is available, cable to be newly laid is installed in such idle conduit.

b) In case where idle conduit is not available, existing small-paired cable is replaced with multi-paired cable. However, in due consideration of cost required and working property involved, decision is made either for cable replacement or for new conduit construction.

2) Provision of New Underground Conduit Facilities

For the provision of new underground conduit facilities, followings are the requirements:

a) To select road where conduit route can be shortest.

b) To select road fit for establishing cross-connecting cabinet.

c) To select road not to be repaired or discontinued by town planning, etc.

d) To select road where river crossings (number of bridges) and railway crossings are few.

e) To select road where underground structures are few so that the construction of work of new underground conduit facilities is easy.

f) To select road of broad width where surfaces traffic seldom interferes with the construction work of new underground conduit facilities.

g) To select road which is not paved.

(2) Underground Conduit

1) Number of Conduit

Number of conduit required (N) is calculated by

$$N = (a+b+c) + (d+e) + (f+g) + (h+i)$$

where

a: Number of conduits for primary cable

b: Spare conduit for primary cable

c: Number of conduits for secondary cable

d: Number of conduits for trunk cable (including coaxial cable and optical fiber cable)

e: Spare conduit for trunk cable

f: Number of conduits for junction cable (including optical fiber cable)

g: Spare conduit for junction cable

h: Number of conduits for special cable (for police, military, CATV, etc.)

i: Spare conduit for special cable

For (d+e), (f+g) and (h+i), consideration is made only for sections where they are necessary, after discussion with PERUMTEL.

2) Conduit Line for Primary Cable

Calculation is made for number of cable units commensurate with estimated demand 20 years after (i.e., as of 2005) in each cross-connecting cabinet area.

Cable units distributed to each cross-connecting cabinet along primary cable route are grouped together by conductor diameters from the far end of primary cable to the exchange.

Sum total of cable units obtained by calculation for each cable conductor diameter in each underground conduit section presents number of conduit lines required for primary cable. Calculation is made by

$$W = \frac{XY}{Z_{max}}$$

where

W: Number of conduit lines of primary cable for each conductor gauge

X: Total number of cable units for each conductor gauge

Y: Conduit marginal ratio

Cable Unit	1-12	13-36	37-96	97-372	373 & over
Y	2.1	2.0	1.9	1.8	1.7

Z_{max}: 0.4 mm ... 24 cable units
0.6 mm ... 12 cable units
0.8 mm ... 6 cable units

3) Environmental Margin

In case where road re-excavation in the future is considered to be difficult as in main roads with especially heavy traffic, environmental margin of 1.2 is applied.

4) Conduit Type

For conduit, PVC pipe is used, in principle. Steel pipe is used mainly where cable burying depth is shallow.

PVC pipe inner diameters are threefold: 100 mm, 63.5 mm and 25.4 mm. 100 mm pipe is used for primary cable route, 63.5 mm pipe between handhole and pit, and 25.4 mm pipe between pit and building.

5) Manhole Spacing

Manhole spacing is determined in all-round consideration of cable branching, cross-connecting cabinet location and road condition. Maximum spacing is:

Straight section .... 200 mm
Curved section .... 100 mm

6) Conduit Alignment

Typical example of conduit alignment is in Figure 6-1.

7) Conduit Location

In case where roadway and sidewalk are clearly distinguished, sidewalk precedes for conduit location. Where no distinction exists between roadway and sidewalk, shoulder is chosen for conduit location.

(3) Manhole, Handhole and Pit

1) Manhole

Manhole is established at cable connecting point, cable branching point, PCM regenerator location, loading coil location, and other key locations from the viewpoint of construction and maintenance.

Manhole must be large enough to accommodate

a) Necessary number of conduit lines
b) Working space
c) Splice case
d) PCM regenerator housing
e) Loading coil

Type and dimensions of manholes recommended by JICA Study Team are in Figure 6-2 (1/7-7/7) and Table 6-6, respectively.

Manhole wherein PCM regenerator housing and loading coil will be established must have 100 cm spacing between bottom floor and lowest cable bearers.

When deciding manhole type wherein to accommodate junction and trunk cables, these cable expansion plans must be taken into consideration.

In case where existing manhole cannot accommodate PCM regenerator housing and loading coil, existing manhole remodelling or appropriate new manhole construction near existing manhole is necessary.

In front of cross-connecting cabinet, manhole must be established. Cable connection is done inside manhole.

2) Handhole

Handhole is established at locations where underground drop wire and underground distribution point (D.P.) which can utilize pit are installed. That is to say, handhole is established at cable splicing points on main secondary cable route in such area where residential district changes into commercial or business office district, viz., in such area where existing demand density is expected to draw sharp upcurve in years to come.

Handhole is established on sidewalk, in principle. Handhole type and dimensions are in Figure 6-2 (7/7).

3) Pit

Pit is established near houses so that underground drop wire can be installed whenever necessary in the future without road re-excavation.

4) Handhole and Pit Cover Levels

Handhole and pit cover levels are the same as sidewalk level, in principle. In case where safety measure is specially required, pit cover level is established about 20 cm lower than sidewalk level and coated with the same material as sidewalk surface.

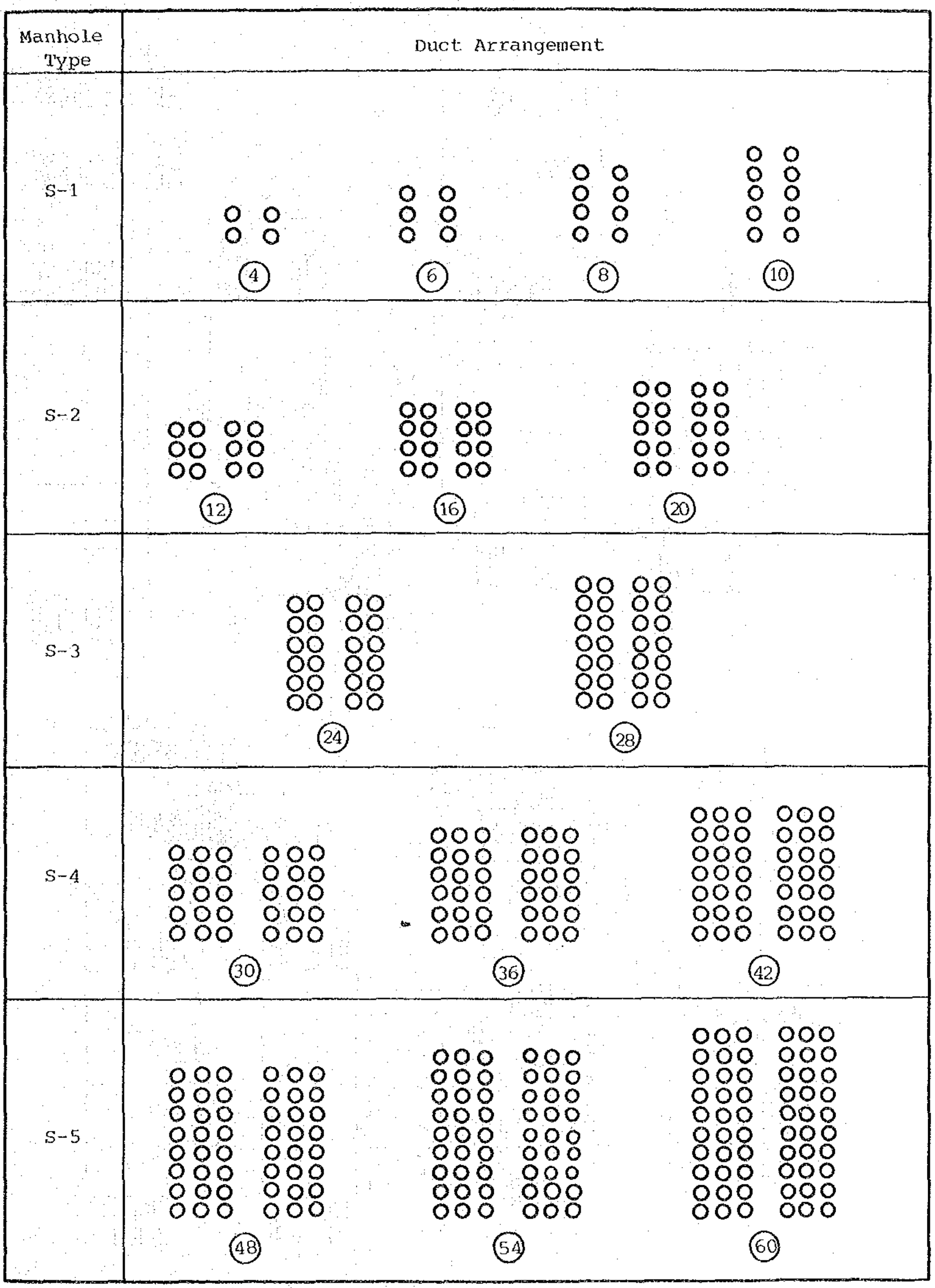


Figure 6-1 Duct Alignment

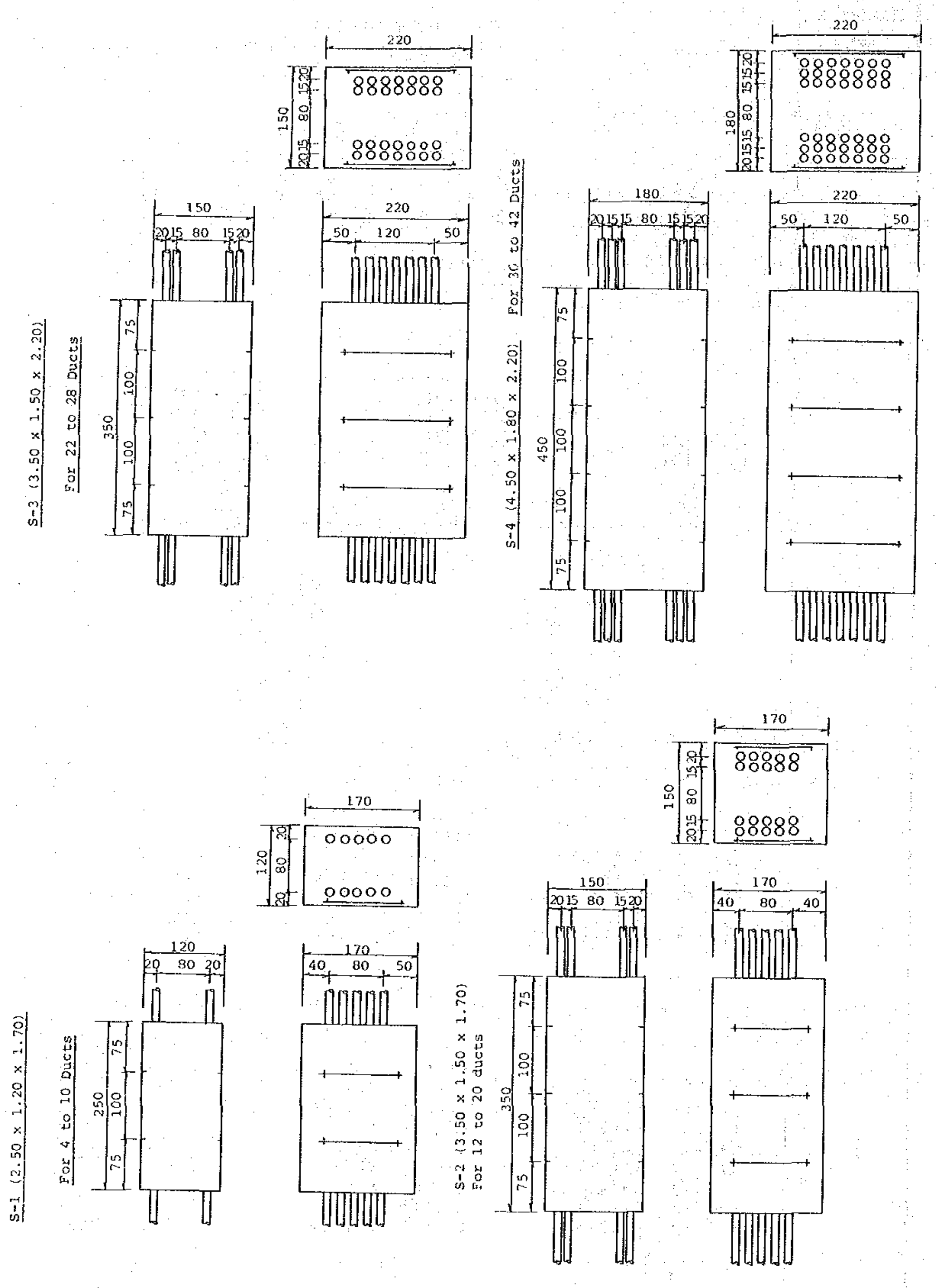
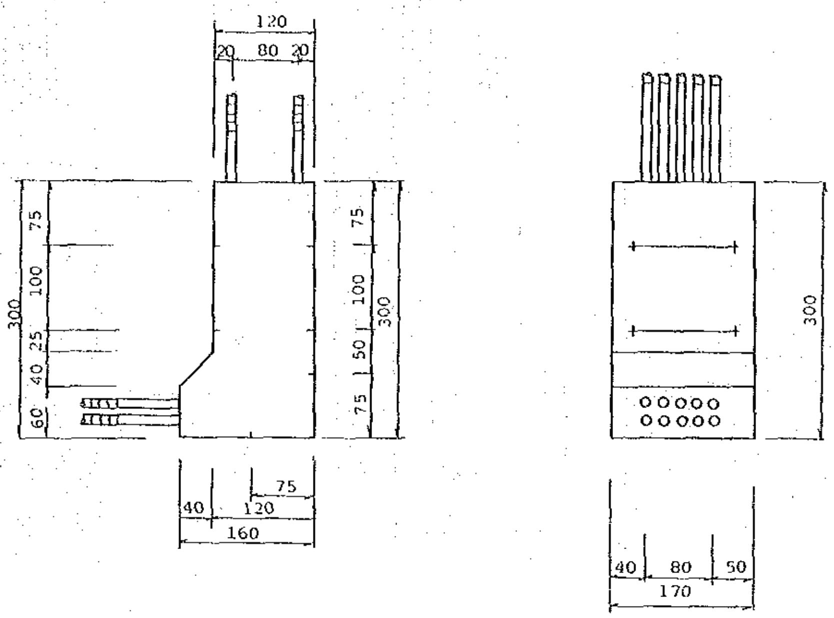


Figure 6-2 (1/7) Manhole Type and Dimensions

L-1 (300 x 120 x 170)

For 4 to 10 Ducts



S-5 (5.00 x 1.80 x 3.00)

For 48 to 60 Ducts

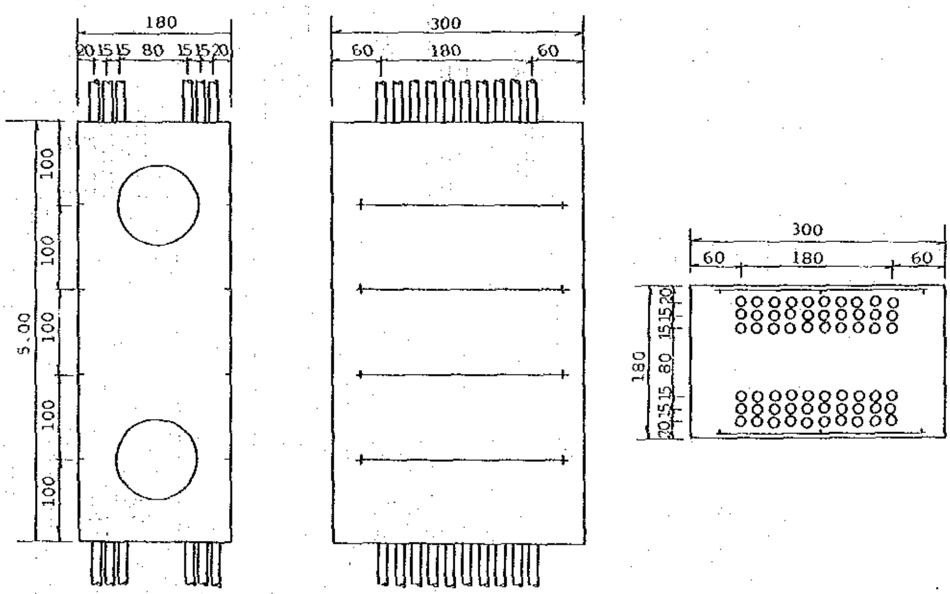


Figure 6-2 (2/7) Manhole Type and Dimensions

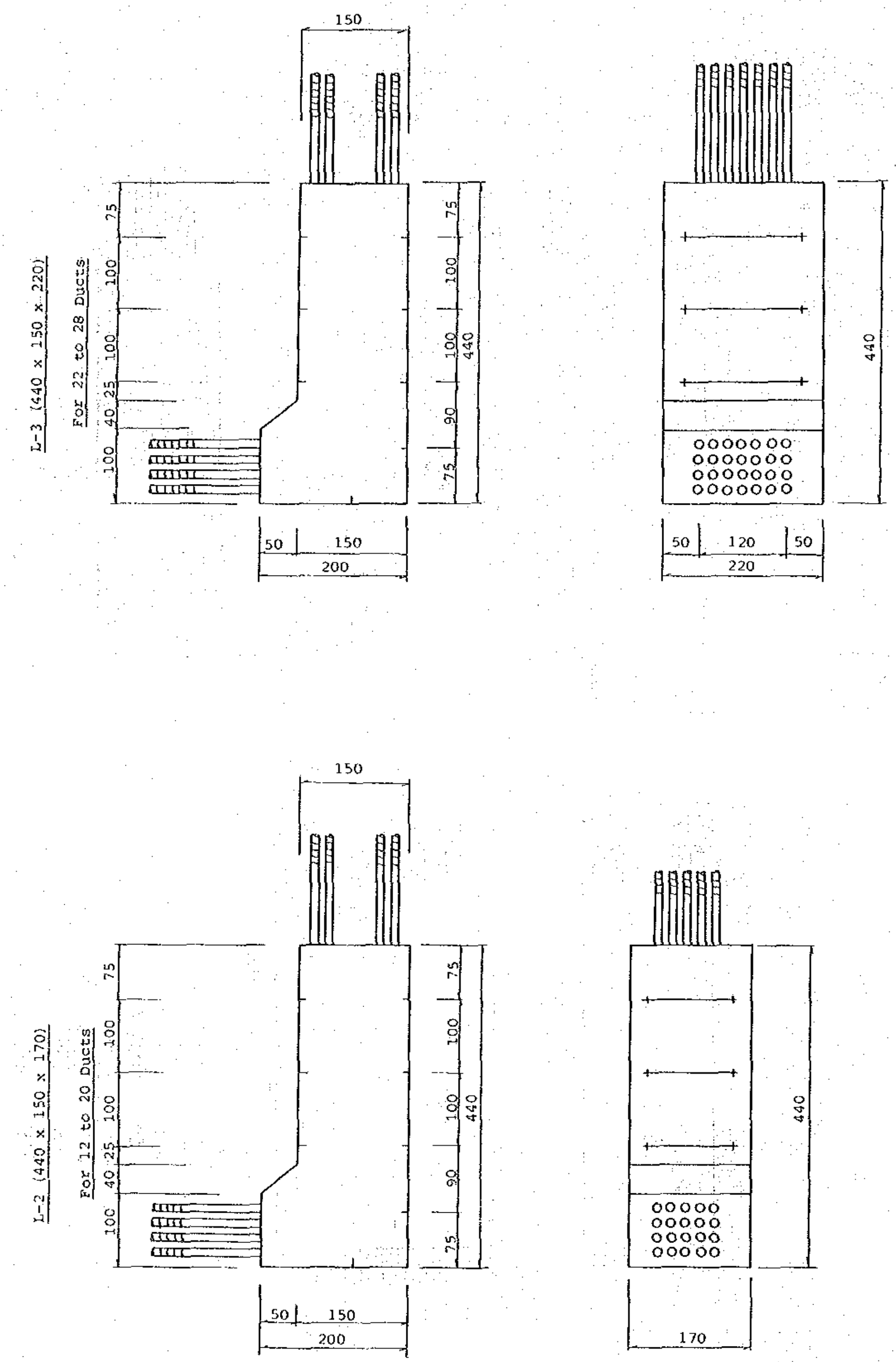
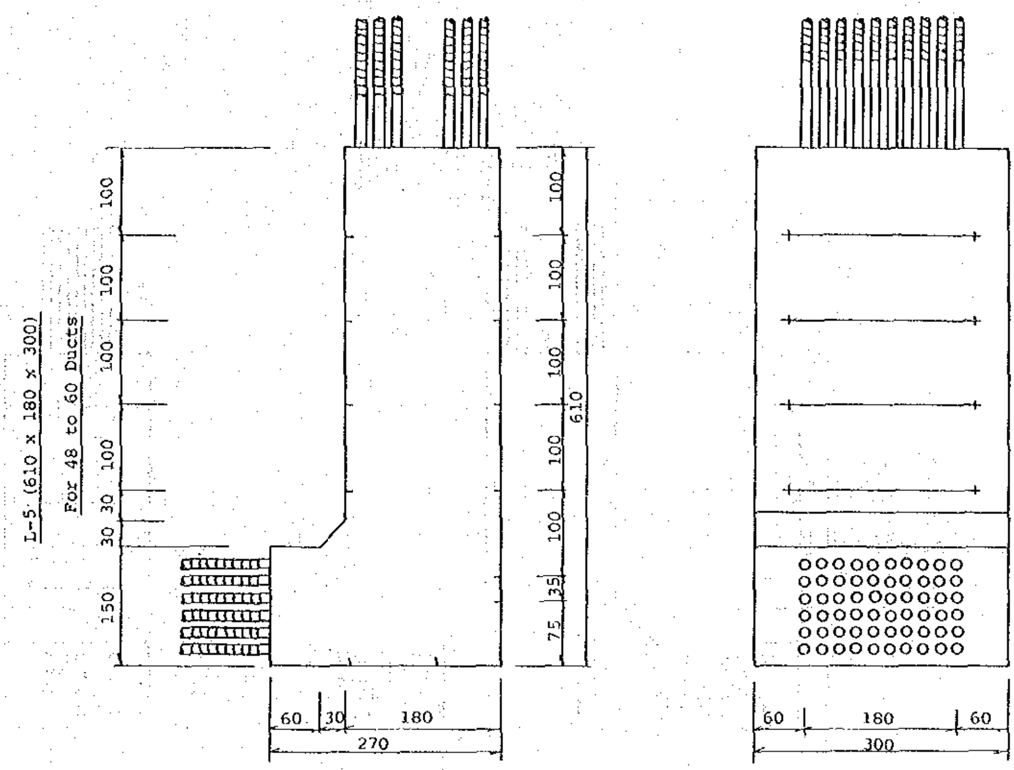


Figure 6-2 (3/7) Manhole Type and Dimensions



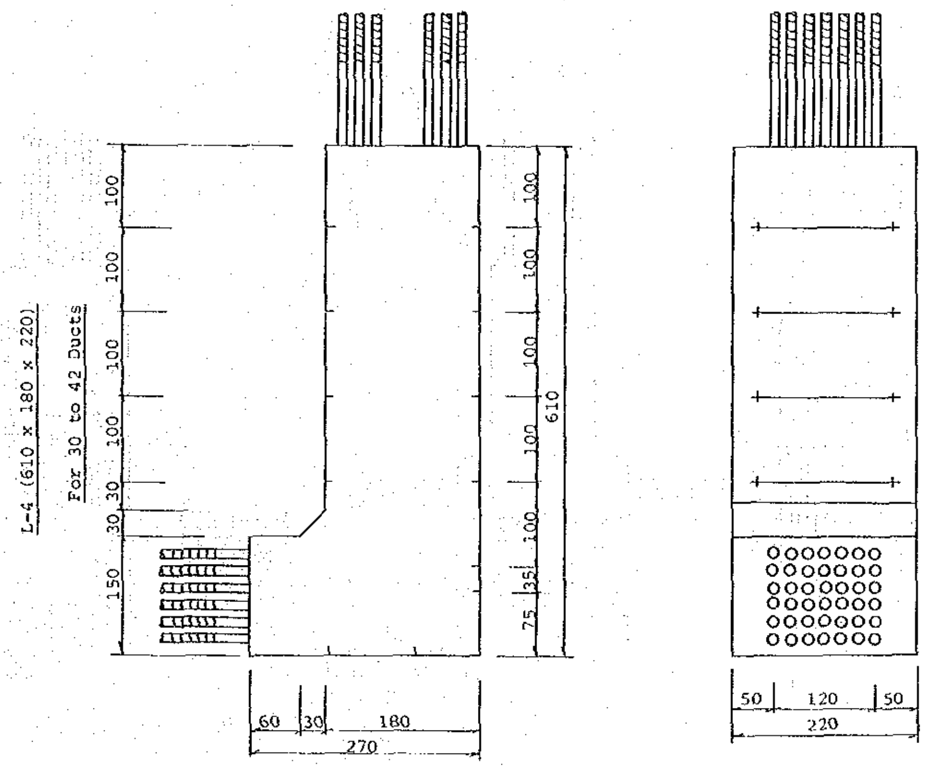
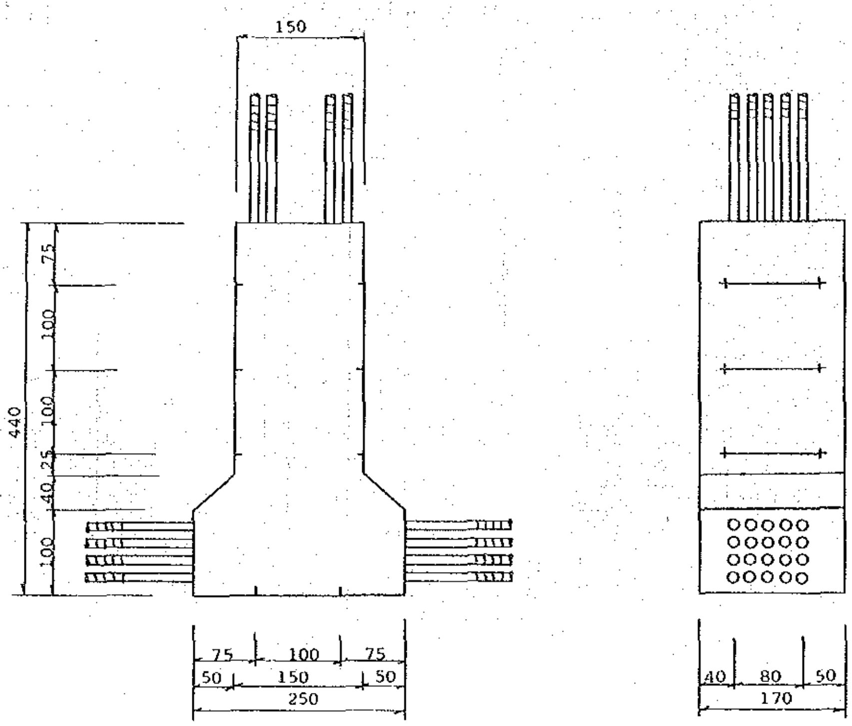


Figure 6-2 (4/7) Manhole Type and Dimensions

T-2 (440 x 150 x 170)
For 12 to 20 Ducts



T-1 (300 x 120 x 170)
For 4 to 10 Ducts

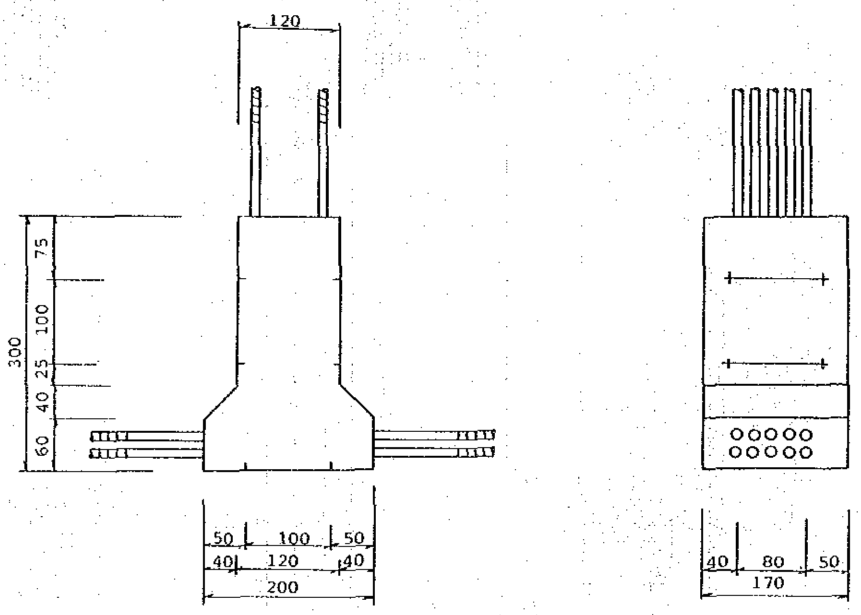


Figure 6-2 (5/7) Manhole Type and Dimensions

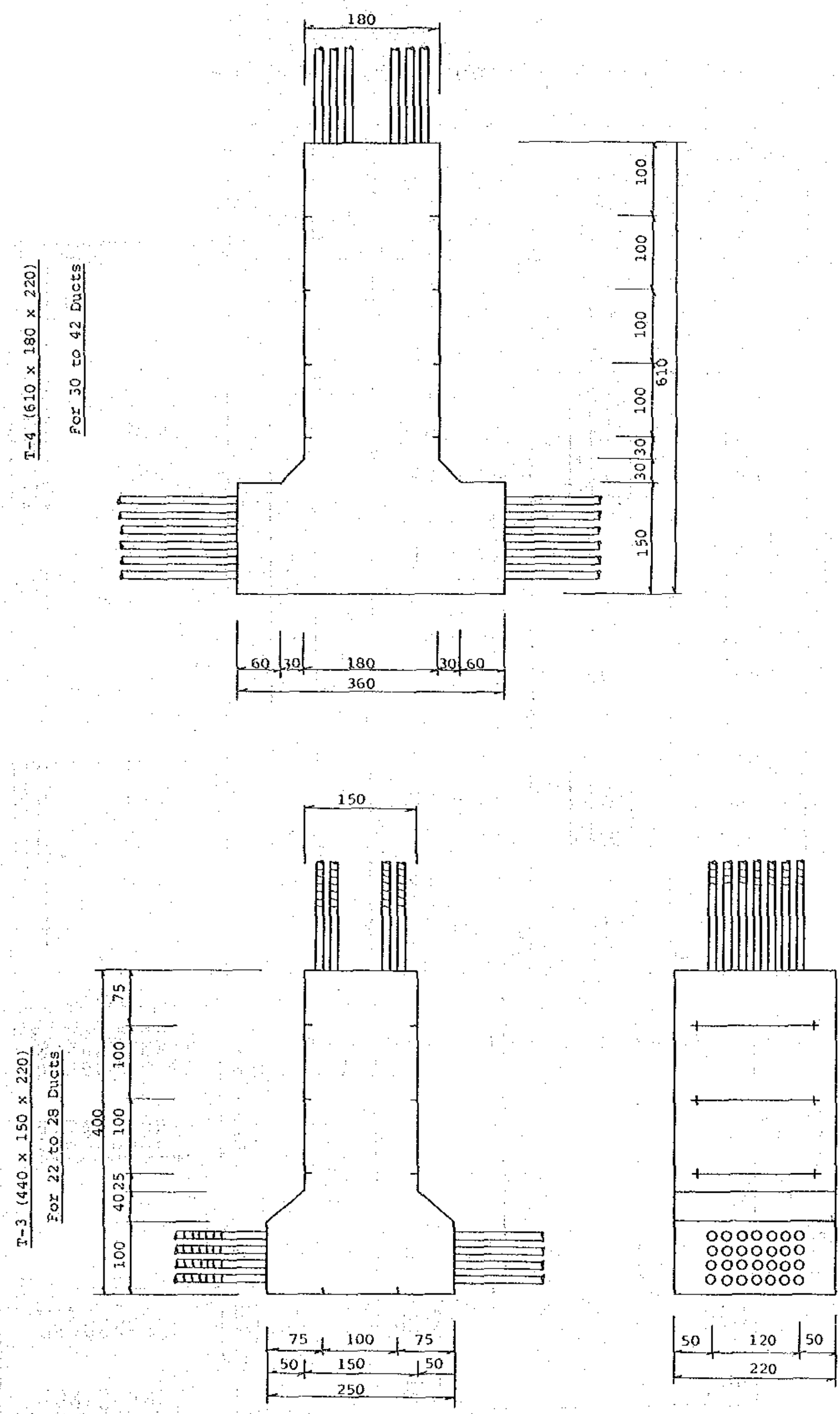


Figure 6-2 (6/7) Manhole Type and Dimensions

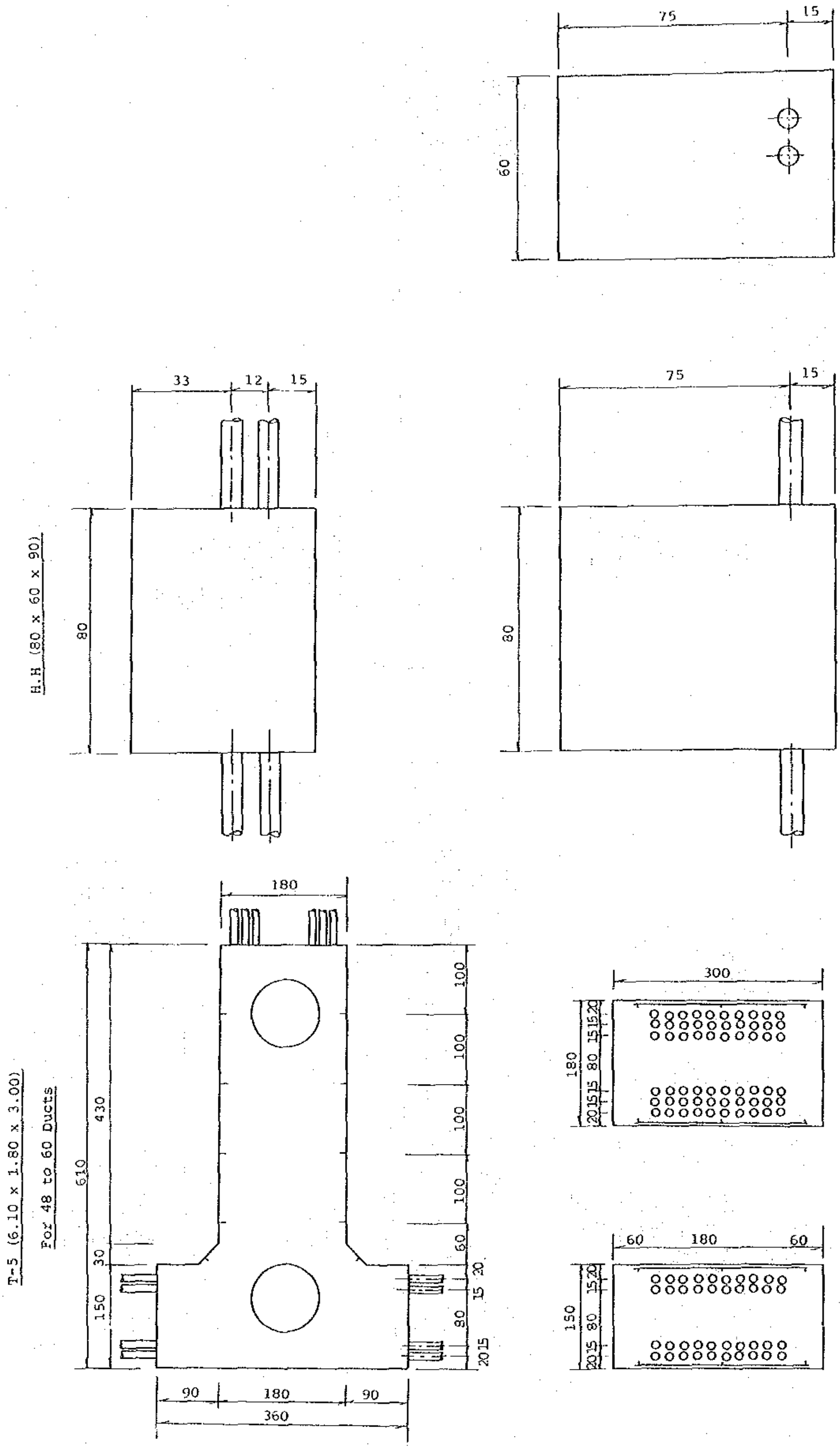


Figure 6-2 (7/7) Manhole Type and Dimensions

Table 6-6 Types and Dimensions of Manhole and Handhole

Manhole Type	Number of Ducts			Inside Dimensions		
	Horizontal	Vertical	Range	Length (cm)	Width (cm)	Weight (cm)
S-1	2	5	2 - 10	250	120	170
S-2	4	5	12 - 20	350	150	170
S-3	4	7	22 - 28	350	150	220
S-4	6	7	30 - 42	450	180	220
S-5	6	10	44 - 60	500	180	300
L-1	2	5	2 - 10	300	120	170
L-2	4	5	12 - 20	440	150	170
L-3	4	7	22 - 28	440	150	220
L-4	6	7	30 - 42	610	180	220
L-5	6	10	44 - 60	610	180	300
T-1	2	5	2 - 10	300	120	170
T-2	4	5	12 - 20	440	150	170
T-3	4	7	22 - 28	440	150	220
T-4	6	7	30 - 42	610	180	220
T-5	6	10	44 - 60	610	180	300
H-H	2	1	2	80	60	90

Note: 50 cm more in depth for manholes wherein to install PCM regenerator housings and loading coils.

6-1-6 Design for Primary Cable Network

Based on demand distribution map, primary cable network is designed. Design procedures follow:

(1) Number of Cable Units to be Distributed to Each Cross-Connecting Cabinet Area

For each cross-connecting cabinet area, calculation is made for cable units commensurate with estimated demand as of year 1993.

(2) Grouping of Units

Cable units distributed to each cross-connecting cabinet area along primary cable route are grouped by conductor diameters from route end to the exchange.

(3) Cable Pairs

Cable to be used is of pairs commensurate with units grouped for each section. Meanwhile, from economic consideration including effective use of conduit multipair cable is used.

(4) Temporary Cross-Connecting Cabinet Area

For primary cable to temporary cross-connecting cabinet area, cable units commensurate with number of existing subscribers, number of registered waiting subscribers and number of unregistered, i.e., latent, waiting subscribers are installed at initial stage. For future expansion, no specific consideration is made.

(5) Free Units

Difference between number of pairs terminated at MDF and number of pairs distributed to each cross-connecting cabinet area forms idle conductors. They are reserved as free units at primary cable terminal or in cross-connecting cabinet.

6-1-7 Design for Secondary Cable Network

Secondary cable pairs are commensurate with estimated demand as of year 2005. Decision procedures follow:

(1) Distribution Area Establishment

Cross-connecting cabinet area is divided into several distribution area along cable route, in consideration of existing cables and road conditions.

(2) Calculation of Cable Units for Distribution Area

Cable units commensurate with estimated demand as of year 2005 in cross-connecting cabinet area is distributed to each distribution area according to demand.

(3) Cable Pairs Decision

For cable pairs, selection is made for such pairs that are commensurate with distributed units. For existing cable, if any, investigation is made as to whether it is usable or not. If usable, existing cable is utilized in cable pairs decision.

(4) Secondary Cable Pairs Reservation

In case where cross-connecting cabinet area contains undeveloped and unoccupied land space, secondary cable pairs in the number to cover such land space are reserved in cross-connecting cabinet or on cable route near the land space concerned.

(5) Distribution Point (D.P.)

For distribution point, selection is made for type and size fit for area or location of installation and commensurate with estimated demand as of year 2005. Selection is made out of the following:

1) Wall type D.P. .... 10, 20 pairs

2) Pole type D.P. .... 10, 20 pairs

3) Underground type D.P. .... 10, 20 pairs

4) Indoor type D.P. ....10, 20, 30, 50, 100, 200 pairs

(6) Special Wiring Area

Areas, where special wiring using handhole, pit, underground distribution point and drop wire is required, are limited to

1) Area where safety measure is necessary;

2) Area where future re-excavation is difficult;

3) Area where environmental integration must be observed.

6-1-8 Exchange Entrance Cable

Exchange entrance cable design must be economically most desirable and justifiable in rationale, conforming to long term plan.

(1) Conduit Selection

For selection of conduit for primary cable entrance to the exchange, the followings are prerequisite:

- Not to impede further primary cable installation for expansion.

- To avoid forced cable bending and cable crossing in the interval from duct entrance to cable bearers and, for this purpose, to begin with lowest duct and proceed gradually to upper ducts.

(2) Cable Arrangement

Cable arrangement to cable racks and cable bearers in cable vault or trench must be fit for entrance conduit location and, for this purpose, begins with lowest cable bearer and proceeds gradually to upper cable bearers.

(3) Cable Termination

Primary cable entered to the exchange is connected to terminating cable and terminated at MDF. Connection point of primary cable and terminating cable is filled with compound to provide moisture proof partition wall.

(4) MDF

MDF to be used is of 800 pairs or more capacity per vertical lane. Cable conductors are terminated at MDF from top to bottom.

6-2 Basic Design of Subscriber Cable Network

6-2-1 Guidelines

Basic design for subscriber cable network is mainly by Section 6-1 "Design Standards for Subscriber Cable Network and Underground Conduit Facilities". Also used are field survey findings and results of discussions with PERUMTEL.

(1) Underground Conduit

1) Underground Conduit Route Reservation

For areas that remain undeveloped at present but are expected to be developed in the future, the provision of underground conduit facilities is deferred until appropriate time to come.

2) Underground Conduit Lines Reservation

For underground conduit route where conduit lines required up to 1993 are relatively small-numbered but after 1993 conduit lines required are expected to increase conspicuously, installation is made for conduit lines based on estimated demand as of 1993. Additional conduit lines commensurate with estimated demand as of 2005 will be installed on appropriate future occasion.

(2) Primary Cable

1) Primary Cable Reservation

For areas that remain undeveloped at present but are expected to be developed in the future, primary cable installation is deferred until appropriate time to come.

2) Existing Cable Utilization

Existing cables that come under categories mentioned below are not utilized in new primary cable network. This is in consideration of maintenance required for such existing cables.

a) Small pair cable of less than 200 pairs

b) Small pair, direct buried cable in urban area

c) Cable whereof service life will be over during design period

d) Cable listed in defective facilities report from maintenance exchange

(3) Secondary Cable

1) Secondary Cable Reservation

For areas where development up to 1993 is slight but after 1993 rapid demand growth can be expected, installation is made for cables with pairs commensurate with number of existing subscribers and of waiting subscribers, as well as demand potential. Additional cable installation to cater for estimated demand as of 2005 is on appropriate future occasion.

2) Existing Cross-Connecting Cabinet Replacement

For existing cross-connecting cabinet of less than 1,600 pairs small capacity and for such existing cross-connecting cabinet not using jelly filled stub cable nor using terminal strip with moisture proof treatment at cable fixing point on rear side of terminal, replacement with new cross-connecting cabinet is made. This is to secure required electric characteristics and desirable maintenability.

3) Existing Cable Utilization

Existing cables that come under categories mentioned below are not utilized in new secondary cable network. This is in consideration of maintenance required for such existing cables.

a) Lead sheathed cable

b) Cable with PE sheath and insulation, whereof plant record is not available or which are not described in plant record

c) Cable listed in defective facilities report from maintenance exchange

4) Model Area Selection

Secondary cable network basic design is for model cross-connecting cabinet areas. These model areas are selections based on field surveys of business office districts, commercial districts, residential districts and factory districts of three objective cities.

Even in areas where demand patterns are of the same type, cross-connecting cabinet area size differs between central district with high demand density and suburban district with low demand density. Hence great difference in required work process also. Thus, for model cross-connecting cabinet areas, two types are chosen to minimize differences. Among three objective cities, one differs from another in cross-connecting cabinet area size and demand density so that types of model cross-connecting cabinet areas chosen for one city differ from those chosen for another.

(4) Facilities Under Planning

Outside plant facilities planned in REPELITA III or facilities planned and about to be constructed by maintenance exchange are regarded as existing facilities in this basic design.

6-2-2 Basic Design for Medan Area

Field survey of Medan area was carried out during latter half of January through upper half of March, 1985. Based on survey findings and in careful consideration of undermentioned items, basic design of nine exchanges in Medan City is made.

Exchange by exchange outline of Medan area subscriber cable network basic design appears below.

(1) Centrum Exchange

In Centrum Exchange area, Centrum I and II Exchanges exist. In not a few sectors of this area, cable lines from both exchanges are intermingled and duplicated.

From the viewpoint of cable facilities maintenance and management, Centrum exchange area is divided, this time, into two, i.e., east and west, distributing sectors, one to be controlled by Centrum I Exchange and the other by Centrum II Exchange.

1) Centrum I Exchange

Most part of existing cables from Centrum I Exchange consist of direct-buried lead-sheathed cables. They are small pair cables installed many years ago and already past their service life. Therefore, they are not utilized, this time.

For that reason, Centrum I Exchange has to carry out cable and civil facilities expansion to a greater extent than Centrum II Exchange. Part of existing cables extending from Centrum II Exchange to Centrum I exchange area are cut over to Centrum I Exchange from the viewpoint of utilizing existing facilities.

MDF now in use is of 200 pairs per vertical lane capacity. In this project, MDF terminals are to be replaced with new terminals having capacity of 800 pairs or more per vertical lane so that they can accommodate 35,000 pairs or more subscriber cables in the future.

In order that Centrum I Exchange can have conduit cables of greater capacity than aforementioned existing MDF capacity drawn in and terminated, necessary measures are taken. They consist of exchange manhole construction on the outside of cable vault, partial cable vault remodelling, and built-in cable frame work installation in cable vault.

2) Centrum II Exchange

Most part of cables now used are plastic cables. Installation is relatively recent or, more precisely, less than 10 years ago. Within 2-3 km from the exchange, they are conduit cables. These cables are utilized to a possible maximum, this time.

Cables extending from Centrum I Exchange to Centrum II Exchange area are not utilized as stated previously.

Newly installed cables by subscriber cable facilities expansion work REPELITA-III are utilized as effectively as possible.

MDF now used is of 1,200 pairs per vertical lane capacity so that it deserves effective utilization. Cable vault in the exchange suffers frequent flooding so that it requires water-proof treatment.

(2) Suka Ramai Exchange

Subscriber cables in this exchange are lead-sheathed cables extending from Centrum I Exchange. Furthermore, these cables are past their service life. They do not qualify for utilization, this time.

Underground conduit facilities are few and they are in western sector that adjoins Centrum Exchange. By subscriber cable facilities expansion work under REPELITA-III, now cable underground conduit installation is expected in northern sector that adjoins Centrum Exchange.

For eastern sector that still remains undeveloped, temporary design is made.

(3) Pulau Brayan Exchange

Subscriber cables in this exchange are lead-sheathed cables extending from Centrum II Exchange. These cables are past their service life. Hence decision not to utilize them, this time.

Underground conduit facilities exist only along Laksana Yos Sudarso Road and in southern sector that adjoins Centrum Exchange.

By subscriber's cable facilities expansion work under REPELITA-III, underground conduit expansion in southern sector and cable installation from Centrum II Exchange are scheduled.

For eastern sector that still remains undeveloped, temporary design is made.

(4) Padang Bulan Exchange

Subscriber cables in this exchange consist of a small number of direct buried cables extending from Centrum II Exchange. No underground conduit facilities exist.

For southern and western sectors where development work is not yet in progress, temporary design is made.

Tuntungan Exchange located on southern side of Padang Bulan Exchange is scheduled to become separate exchange on appropriate future occasion. Therefore, to Tuntungan Exchange area, temporary cable installation from Padang Bulan Exchange is scheduled.

(5) Cinta Damai Exchange

To Cinta Damai Exchange, direct buried and aerial cables are distributed from Centrum II Exchange. No underground conduit facilities exist.

In eastern sector of Cinta Damai Exchange area, which adjoins Centrum Exchange, direct buried primary cable is newly installed, extending from Centrum II Exchange, by subscriber cable facilities expansion work under REPELITA-III.

Part of southern sector still remains undeveloped and is without roads. Hence temporary design is made.

(6) Simpang Limun Exchange

At present, in Simpang Limun Exchange area, aerial cable extends from Centrum I Exchange.

Southeastern sector still remains undeveloped except along major road. Therefore, temporary design is made.

(7) Tanjung Mulia Exchange

At present, in Tanjung Mulia Exchange area, small pair aerial cable extends from Centrum II Exchange.

Most part except the sectors along Laksana Yos Sudarso road are still undeveloped and temporary design is made.

(8) Belawan Exchange

Belawan Exchange is existing exchange. Toll circuit to/from Medan City consists of UHF circuit.

In REPELITA-IV program, Belawan Exchange constitutes one of local exchanges in Medan multi-exchange area. As such, junction cable is installed from Medan City, providing new PCM circuit.

All subscriber cables of Belawan Exchange are direct buried. In REPELITA-IV program, underground conduit is newly constructed wherein to accommodate primary cable. For secondary cable, effective utilization to a possible maximum is planned except for lead sheathed cable.

(9) Labuhan Exchange

At present, in Labuhan Exchange area, small pair aerial cable extends from Centrum II Exchange.

Most part except the sectors along main road are still undeveloped and temporary design is made.

6-2-3 Basic Design for Semarang Area

Field survey of Semarang area was carried out during latter half of January through upper half of March, 1985. Based on survey findings and in careful consideration of undermentioned items, basic designs of seven exchanges in Semarang City are made.

Exchange by exchange outline of Semarang area subscriber cable network basic design follows:

(1) Semarang I Exchange

Most part of cables now used are direct-buried lead-sheathed cables. Installation was many years ago so that those cables are already past their service life. Therefore, existing cables except recently installed PE sheathed cables do not qualify for utilization, this time.

Underground conduit facilities exist only in junction cable section between Semarang I and II Exchanges.

New exchange building to be constructed in Semarang I Exchange premise is to have new switching equipment installed. Therefore, all cables are to be drawn in to new exchange building wherein to be terminated.

Further decision, this time, is to establish cable vault and MDF in new exchange building and cable room in existing exchange building basement, and to install conduits between new and existing exchange buildings, wherein to install tie cable.

For new and existing MDFs, new terminals with capacity of 800 pairs or more per vertical lane are used.

(2) Semarang II Exchange

All cables now used are PE-sheathed cables installed recently. For these cables, as effective utilization as possible is planned.

To cater for rapidly growing demand in Semarang II Exchange area and environs, subscriber cable facilities expansion work is planned by REPELITA-III. By this plan, underground cable and conduit facilities from Semarang II Exchange are broadly expanded.

For MDF also, additional installation is planned by REPELITA-III program. This design contemplates further expansion of new MDF installation.

(3) Tugu Exchange

Cables now used in Tugu Exchange area are direct-buried lead-sheathed cables extending from Semarang I Exchange. Both installation date and buried cable location cannot be clarified. Hence decision not to utilize those cables, this time.

In Tugu Exchange area, new underground cable and conduit facilities planned by subscriber cable facilities expansion work under REPELITA-III are from Semarang II Exchange.

For Mijen sector, design is temporary pending until future demand growth. Cross-connecting cabinet is established in central part of sector with cable installation from Tugu Exchange.

(4) Banyumanik Exchange

Cable now used in Banyumanik Exchange area is small pair aerial cable only that extends from Semarang II Exchange.

In this area, underground cable and conduit facilities planned by subscribes cable facilities expansion work under REPELITA-III are extended from Semarang II Exchange.

In Gunung Pati sector in western part of subscriber area, cable installation at present is from Ungaran Exchange in suburban Semarang.

At present, Gunung Pati sector is small demand potential sector so that, for this sector, temporary design is made, providing for cable installation from Banyumanik Exchange. On appropriate future occasion when demand arises, separate Gunung Pati Exchange establishment is scheduled.

(5) Majapahit Exchange

Cables now used in Majapahit Exchange area are small pair direct-buried lead-sheathed cables extending from Semarang I Exchange. Both installation date and buried cable location are unidentifiable. Hence decision not to utilize those cables is mode this time.

In this area, underground cable and conduit is facilities planned by subscriber cable facilities expansion work under REPELITA-III are extended from Semarang II Exchange.

(6) Genuk Exchange

Cables now used in Genuk Exchange area are small pair direct-buried lead-sheathed cable and aerial cable only that extend from Semarang I Exchange.

Considering their installation date, these cables are not utilized, this time.

(7) Mang Kang Exchange

No existing cable is in this exchange area. Most part except the sector along Siliwangi Road is still undeveloped and temporary design is made.

6-2-4 Basic Design for Solo City

Field survey of Solo City was carried out during upper half of February through upper half of March, 1985. Based on survey findings and in careful consideration of undermentioned items, basic designs are made for two exchanges in Solo City.

Exchange by exchange outline of Solo area subscriber cable network basic design is as under.

(1) Solo I Exchange

Most part of existing cables in Solo I Exchange area are direct-buried and lead-sheathed cables. Installation dates are back to many years ago so that those cables are already past their service life. Therefore, existing cables except PE-sheathed cables are not utilized, this time.

Underground conduit facilities seldom exist.

In this area, underground cable and conduits are planned by subscriber cable facilities expansion work under REPELITA-III and most effective utilization is planned. Also by REPELITA III, new exchange manhole construction and MDF expansion are planned.

MDF now in use is of 200 pairs per vertical lane capacity. By REPELITA-IV, existing MDF terminals are replaced with new terminals having capacity of 800 pairs or more per vertical lane so that more than 24,000 pairs subscriber cables can be accommodated.

According to city planning, incorporation of eastern and southern suburban sectors into Solo City is scheduled. This fact is taken into account in underground conduit and subscriber cable design.

(2) Solo II Exchange

Cables extending from Solo I Exchange to Solo II Exchange area are not utilized, this time. Reason is aforementioned. Instead, for underground cable and conduit facilities newly established by REPELITA III program, most effective utilization is planned.

According to city planning, incorporation of southern, western and northern suburban sectors into Solo City is scheduled. This fact is taken into account in underground conduit and subscriber cable design.

6-3 Amount of Major Works

Amount of major works is calculated is by basic design drawings, including underground conduit plan, primary cable map and secondary cable plan, prepared in preceding Section 6-2.

For secondary cable, acmount of major works is calculated by classification of cross-connecting cabinet areas of each of three objective cities according to model cross-connecting cabinet area for each such city, and by summing up of classified data.

For underground conduit facilities, primary cable and secondary cable, summary for amount of major works appears in Table 6-7.

Table 6-7 (1/3) Amount of Primary Cable

Item	Unit	Medan	Semarang	Solo	Total
1. Duct Cable					
0.4 mm - 1200 pairs	km	49.5	24.9	8.8	83.5
0.4 mm - 800 pairs	km	9.3	9.9	2.7	21.9
0.4 mm - 600 pairs	km	14.8	9.7	4.1	28.6
0.4 mm - 400 pairs	km	12.5	7.4	1.9	21.8
0.4 mm - 300 pairs	km	1.7	9.8	1.8	13.3
0.4 mm - 200 pairs	km	0.2	4.6	0.2	5.0
0.6 mm - 800 pairs	km	84.0	78.8	23.2	186.0
0.6 mm - 600 pairs	km	29.6	23.9	4.6	58.1
0.6 mm - 400 pairs	km	7.7	18.6	6.0	32.3
0.6 mm - 300 pairs	km	2.7	14.5	4.3	21.5
0.6 mm - 200 pairs	km	2.2	6.0	3.3	11.5
0.8 mm - 400 pairs	km	5.1	26.7	8.3	40.1
0.8 mm - 300 pairs	km	9.4	9.5	8.2	27.1
0.8 mm - 200 pairs	km		16.8		16.8
2. Burried Cable					
0.4 mm - 400 pairs	km	0.2			0.2
0.6 mm - 200 pairs	km		0.7		0.7
0.8 mm - 200 pairs	km		12.8		12.8

Table 6-7 (2/3) Amount of Underground Conduit Facilities

Item	Unit	Medan	Semarang	Solo	Total
1. Manhole					
S - 1	pcs	321	456	118	895
S - 2	pcs	88	69	34	191
S - 3	pcs	18	16	8	42
S - 4	pcs	2	7	2	11
L - 1	pcs	32	78	22	132
L - 2	pcs	13	20	3	36
L - 3	pcs	9	7	2	18
L - 4	pcs	1	2	1	4
L - 5	pcs	1			1
T - 1	pcs	1	11	2	14
T - 2	pcs	8	1	4	13
T - 3	pcs	2	3	1	6
T - 4	pcs	9	3	1	13
T - 5	pcs	2	1	1	4
Handhole	pcs	2	6		8
2. Duct					
2 way	km	1.1	0.9		2.0
4 way	km	50.0	59.8	16.1	125.9
6 way	km	19.7	19.2	6.4	45.3
8 way	km	6.7	10.4	2.1	19.2
10 way	km	6.1	3.0	1.1	10.2
12 way	km	3.0	2.0	2.1	7.1
16 way	km	4.1	3.7	3.9	11.7
20 way	km	0.2	3.5	0.9	4.6
24 way	km	1.7	3.9	0.6	6.2
28 way	km	1.6	0.6	0.2	2.4
30 way	km	0.4	0.3	0.2	0.9
36 way	km	0.1			0.1
42 way	km	0.1	0.1		0.2
48 way	km	0.1	0.1		0.2

Table 6-7 (3/3) Amount of Secondary Cable

Item	Unit	Medan	Semarang	Solo	Total
1. Aerial Cable					
0.4 mm - 10 pairs	km		6.1		6.1
0.4 mm - 30 pairs	km	0.2	4.2		4.4
0.4 mm - 50 pairs	km	1.3	1.2		2.5
0.4 mm - 100 pairs	km		2.6		2.6
0.6 mm - 10 pairs	km		25.4		25.4
0.6 mm - 30 pairs	km	2.5	17.3		19.8
0.6 mm - 50 pairs	km	15.1	5.0		20.1
0.6 mm - 100 pairs	km		10.6		10.6
0.8 mm - 10 pairs	km		14.4		14.4
0.8 mm - 30 pairs	km	0.6	31.9	1.1	33.6
0.8 mm - 50 pairs	km	3.8	11.2	1.0	16.0
0.8 mm - 100 pairs	km		21.5		21.5
2. Burried Cable					
0.4 mm - 10 pairs	km	44.2	74.8	2.4	121.4
0.4 mm - 20 pairs	km	64.8	34.6	22.3	121.7
0.4 mm - 30 pairs	km	20.0	13.8	2.6	36.4
0.4 mm - 50 pairs	km	46.7	20.5	17.7	84.9
0.4 mm - 100 pairs	km	162.9	56.5	30.7	250.1
0.4 mm - 200 pairs	km	66.3	35.8	1.6	103.7
0.6 mm - 10 pairs	km	13.6	106.9	1.4	121.9
0.6 mm - 20 pairs	km	13.5	40.3	16.9	70.7
0.6 mm - 30 pairs	km	10.2	12.4	1.5	24.1
0.6 mm - 50 pairs	km	41.6	24.7	13.7	80.0
0.6 mm - 100 pairs	km	46.6	71.3	29.2	147.1
0.6 mm - 200 pairs	km	16.3	43.8	2.4	62.5
0.8 mm - 10 pairs	km		16.0		16.0
0.8 mm - 20 pairs	km		7.8	1.1	8.9
0.8 mm - 30 pairs	km	0.6	3.6		4.2
0.8 mm - 50 pairs	km	3.8	5.0	1.0	9.8
0.8 mm - 100 pairs	km		13.5	6.2	19.7
0.8 mm - 200 pairs	km		20.7	0.8	21.5
3. Cabinet	pcs	266	226	69	561
4. Terminal Box	pcs	4,500	7,000	1,300	12,800
5. Pole	pcs	4,700	4,500	1,200	10,400