CHAPTER 7 JUNCTION CABLE NETWORK

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7-1 Transmission System Design Standards

7-1-1 PCM Cable System

PCM cable system signifies wire transmission system which uses paired cable or quadded cable as transmission media and which regenerates and repeats 2048 kbit/s digital signal that corresponds to 30 telephone channels.

7-1-1-1 Bit Error Objective

In digital transmission system, bit error rate is used as transmission characteristic determinant. In this study, bit error rate objective per regenerative repeating is set at 1×10^{-9}.

7-1-1-2 System Accommodation

For accommodation of each digital system in cable pairs of general paired cable or quadded cable designed for voice transmission, special consideration is required. However, when digital transmission cable with metal compartment is used, a number of systems of the same direction of transmission have only to be accommodated in cable pairs inside the same compartment, and no other specific rule applies. In this study, recommendation is made for use of jelly-filled, PE-insulated, star quad cable with metal compartment, because this cable can be produced in Indonesia.

When the above cable is used, system accommodation procedures are as under.

(1) "Up" transmission direction of each system be accommodated in cable pair inside the same compartment.

(2) "Down" transmission direction of each system be accommodated in cable pair inside other compartment.

Typical example of above system accommodation in cable pairs is graphically presented in Figure 7-1.

7-1-1-3 Repeater Spacing Design

(1) Maximum Repeater Spacing (d max)

Maximum repeater spacing is restricted by maximum gain of regenerative repeater. Correlation between such maximum gain and maximum repeater spacing is expressed by

$$d\ max \leq \frac{G}{(1 + \alpha \cdot \Delta t)(1 + 3\beta)L_o}$$

where

d max: Maximum repeater spacing (km)

G: Maximum gain of regenerative repeater (dB)

α: Cable attenuation temperature coefficient (2×10^{-3}/°C)

Δt: Temperature variation range (Underground, 3 big cities: 6°C)

β: Cable attenuation variation from conductor to conductor (0.03)

L_o: Mean cable attenuation per km at 1024 kHz, 20°C (dB/km)

When maximum gain of regenerative repeater is assumed 40 dB, the foregoing formula boils down to

$$L_o \cdot d \max \leq 36.26 \text{ dB}$$

Mean cable attenuation (L_o) at 1024 kHz, classified by conductor diameter, is given as follows:

Conductor Diameter (mm)	Cable Attenuation (dB/km)
0.6	14.16
0.8	10.12

Therefore, maximum repeater spacing (d max) by cable conductor diameter is:

Conductor Diameter (mm)	Maximum Repeater Spacing (km)
0.6	2.56
0.8	3.58

(2) Repeater Spacing in Adjacent Section to Telephone Exchange (d_{END})

Repeater spacing in adjacent section to telephone exchange must be shorter than in other repeater section. This is subject to pulse-like inductive noise that originates from switching equipment. With a view to securing allowable bit error rate for such section, assume that cable attenuation be 20 dB. Then, repeater spacing in that section can be expressed as

$$d_{END} \leq \frac{20}{(1 + \alpha \cdot \Delta t)(1 + 3\beta) L_o}$$

Therefore, d_{END} can be obtained by

$$L_o \cdot d_{END} \leqq 18.13 \text{ dB}$$

d_{END} classified by cable conductor diameter follows:

Conductor Diameter (mm)	d_{END} (km)
0.6	1.28
0.8	1.79

(3) Repeater Spacing Restricted by Crosstalk

Generally, repeater spacing restricted by near-end crosstalk from many other systems is shorter than repeater spacing restricted by far-end crosstalk. In this study, repeater spacing calculation is made from near-end crosstalk.

Maximum repeater spacing by near-end crosstalk is expressed by

$$X_N - L_o d\,(1 + \alpha \cdot \Delta t)(1 + 3\beta) \geqq S(\varepsilon) + 3$$

$$X_N = -10 \log_{10} \left[\sum_i^n 10^{-\frac{x_i}{10}} \right]$$

$$x_i = M_{Ni} - f(\sigma_{Ni}, n_i)$$

where

X_N: Sum of effective near-end crosstalk attenuation from N-systems, at 1024 kHz (dB)

M_{Ni}: In actual system accommodation in cable pairs, N-systems are accommodated in several different units. Near-end crosstalk attenuation of one unit differs from that of another. Assume that mean near-end crosstalk attenuation of i-th unit is M_{Ni}. Then,

$$\begin{array}{ccc} M_{N1} - f(\sigma_{N1}, n_1) & = & x_1 \\ \vdots & & \vdots \\ M_{Ni} - f(\sigma_{Ni}, n_i) & = & x_i \end{array}$$

$f(\sigma, n)$ value is graphically presented in Figure 7-2.

$f(\sigma_{Ni}, n_i)$: Multiple crosstalk power of i-th unit (dB)

σ_{Ni}: Standard deviation of M_{Ni} (dB)

n_i: Number of systems in i-th unit

$S(\varepsilon)$: Allowable S/N ratio required of regenerative repeater so as to attain objective bit error rate per repeater section. Objective bit error rate and S/N ratio are:

Objective Bit Error Rate	$S(\varepsilon)$
10^{-9}	29.6 dB
10^{-8}	29.0 dB
10^{-7}	28.3 dB

3: Design margin (dB)

d: Repeater section length (km)

Repeater section length (d) obtained by the foregoing formula must satisfy the following requirement:

$$d_T \leq d \leq d_{MAX}$$

In case where d is smaller than d_T, d applies to adjacent repeater section to telephone exchange. If d is greater than d_{MAX}, d_{MAX} instead of d applies to that repeater section.

M_{Ni} as mean near-end crosstalk attenuation at 1024 kHz is 85 dB in interconductor value between metal compartments according to PERUMTEL's specification. Assuming that its standard deviation is 5 dB, calculation is made to obtain relationship between repeater section length (d) and number of systems. Calculation result is in Figure 7-3.

7-1-1-4 Power Feeding Design

Power feeding to regenerative repeater is done by d.c. series feed on system by system basis, using phantom circuit of cable conductor which is used for digital signal transmission.

Feed section length (d) is obtained by

$$d \leq \frac{E - nV}{(1 + \alpha \cdot \Delta t) RI} \quad \text{(km)}$$

where

d: Maximum feed section length (km)

E: Feed voltage (volt)

I: Feed current (ampere)

V: Voltage drop per regenerative repeater (volt)

n: Number of regenerative repeaters in feed section

R: Phantom circuit loop resistance at 20°C (ohm/km)

α: Line resistance temperature coefficient (°C)

Δt: Temperature variation range (°C)

In this study, parameter values are assumed as under whereby to identify n and R correlation. This correlation appears in Figure 7-4.

$E = 200$ (V)

$I = 0.05$ (ampere)

$V = 10$ (volt)

$\alpha = 3.93 \times 10^{-3}$ (/°C)

$\Delta t = 6°C$

7-1-1-5 Standby System

Standby transmission system with regenerative repeater is established for each repeater route. Purpose is to diminish non-operating hours of main system due to regenerative repeater failure. For each transmission route, one standby transmission system suffices regardless of the number of working systems.

Standby system configuration is in Figure 7-5.

7-1-1-6 Cable Pairs

Cable pairs required for this digital system transmission are two pairs per system. Also required are conductors for regenerative repeater failure location, order wire system (2-wire/4-wire system) and alarm system. Total requirement for cable pairs (N) is expressed by

$$N = 2n + 5 + m$$

where n denotes number of systems and m stands for cable pairs required for other purpose than abovementioned.

7-1-1-7 Signal Conversion

For PCM multiplex equipment and analog switching equipment interface, signal conversion is indispensable. This signal conversion is to make channel associated signals of PCM circuit conform to switching equipment specifications. Converter for this signal conversion is usually mounted on PCM multiplex equipment.

7-1-1-8 Equipment Configuration and Wiring System

For terminal and intermediate equipment configuration and main wiring arrangement, block diagram is in Figure 7-6.

7-1-1-9 Equipment Location

Equipment should preferably be installed in room located near MDF and appropriately furnished for dust-proofing.

Some of existing telephone exchanges in three objective areas permit acquisition of equipment room near MDF; at other exchanges, building remodelling or annex is required. Floor space to be acquired should be large enough for installation of all equipment commensurate with the number of systems in operation by final project year.

7-1-1-10 Power Supply to Equipment

Required power for all kinds of equipment to be installed is supplied from d.c. -48 V or d.c. -60 V power source for switching equipment. This means that power supply equipment capacity must be large enough to cater completely for power consumption by switching equipment and digital transmission equipment. In case where power supply equipment capacity falls short of above requirement, separate power supply equipment for digital transmission equipment should be established.

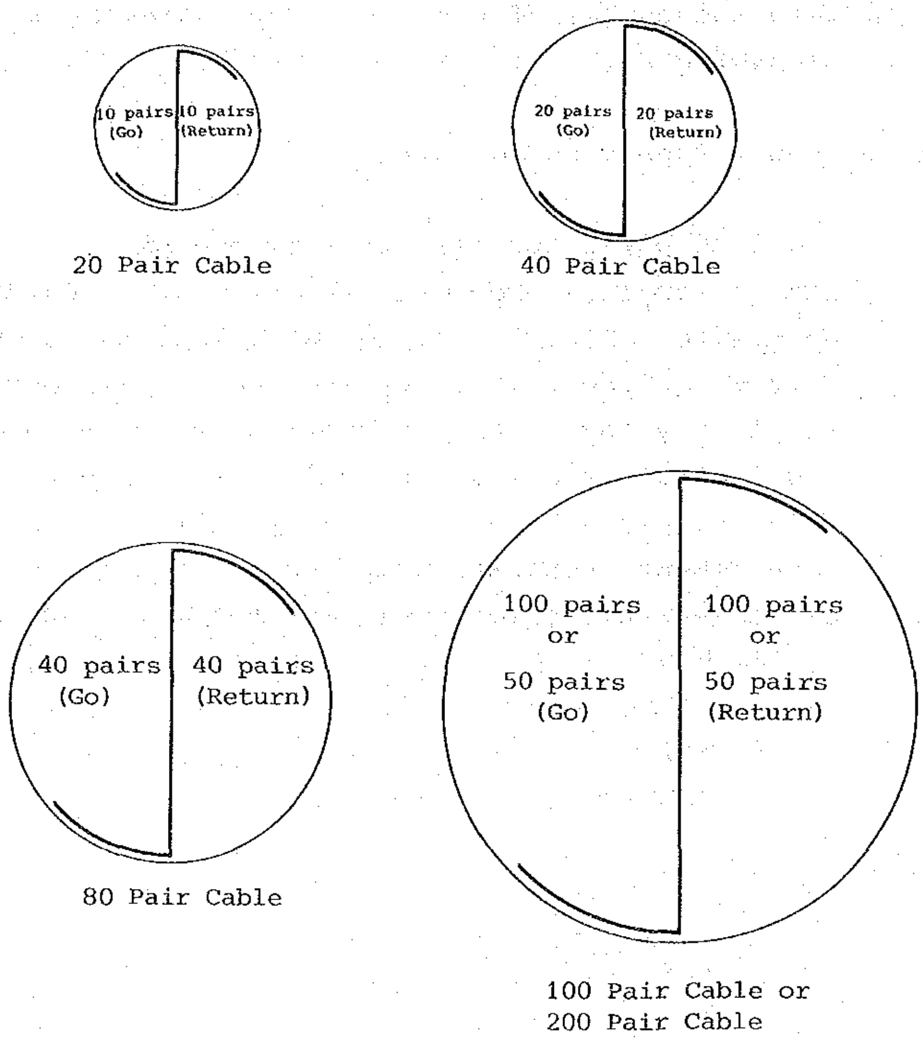


Figure 7-1 PCM Pair Assignment

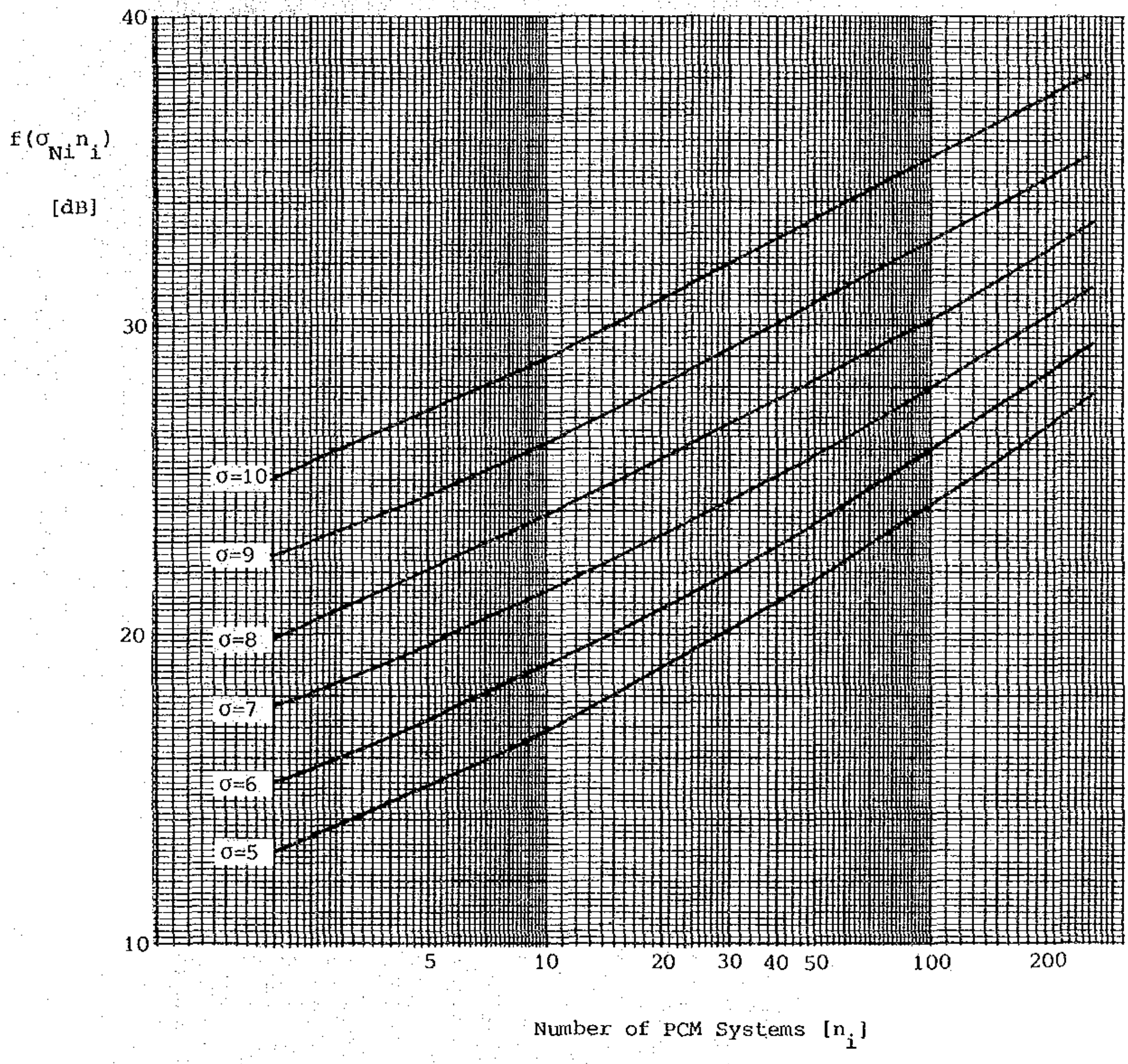


Figure 7-2 Multiple Crosstalk Power

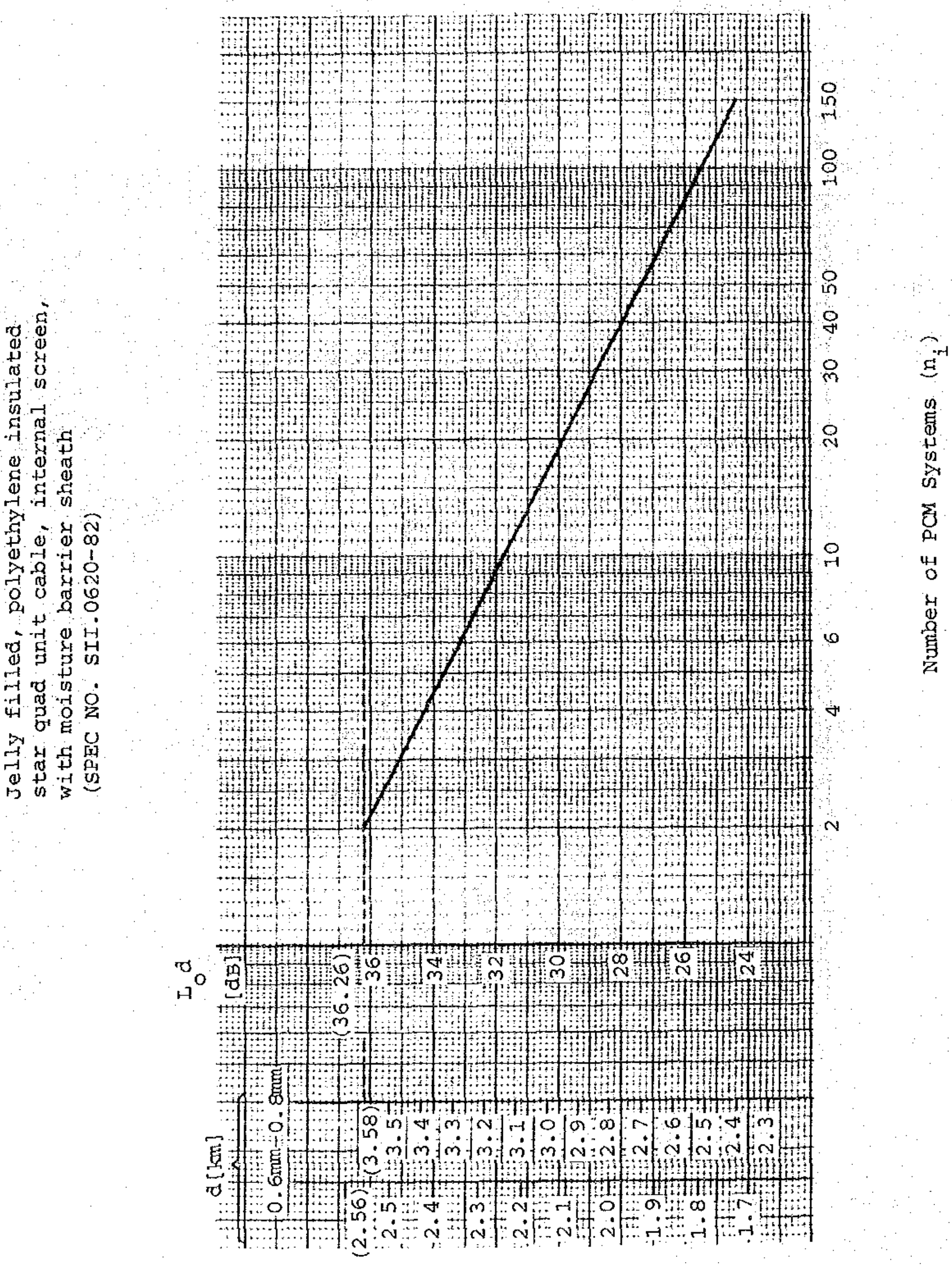


Figure 7-3 Repeater Spacing

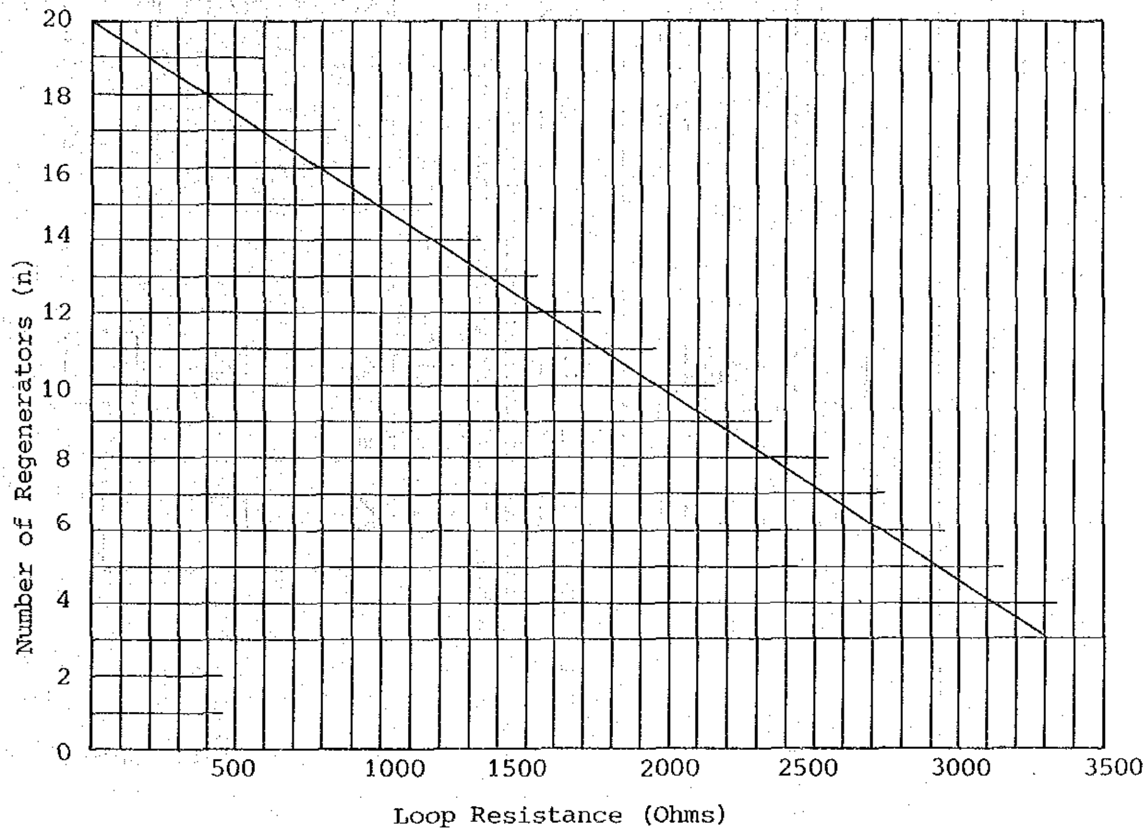


Figure 7-4 Maximum Power Feeding Distance

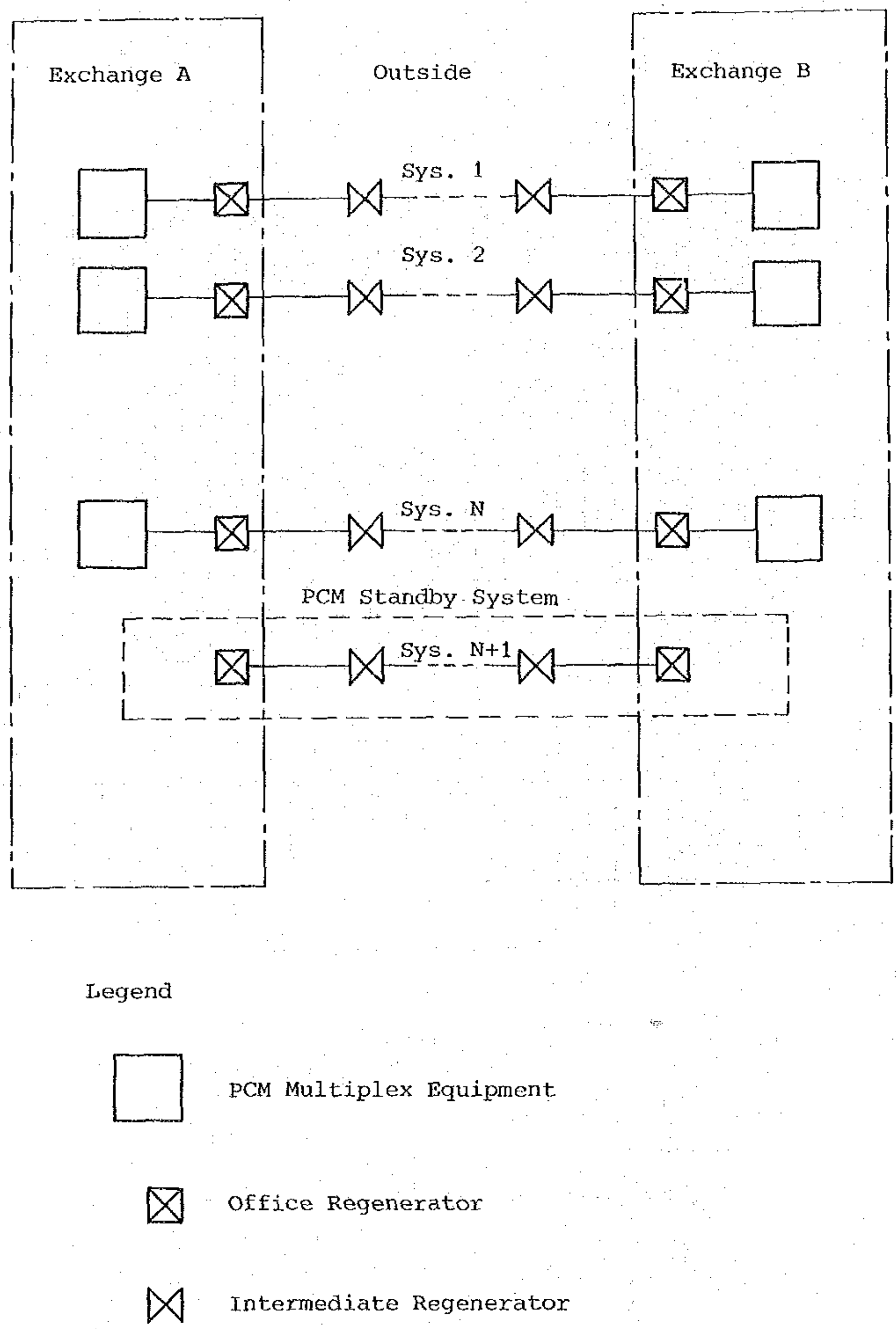
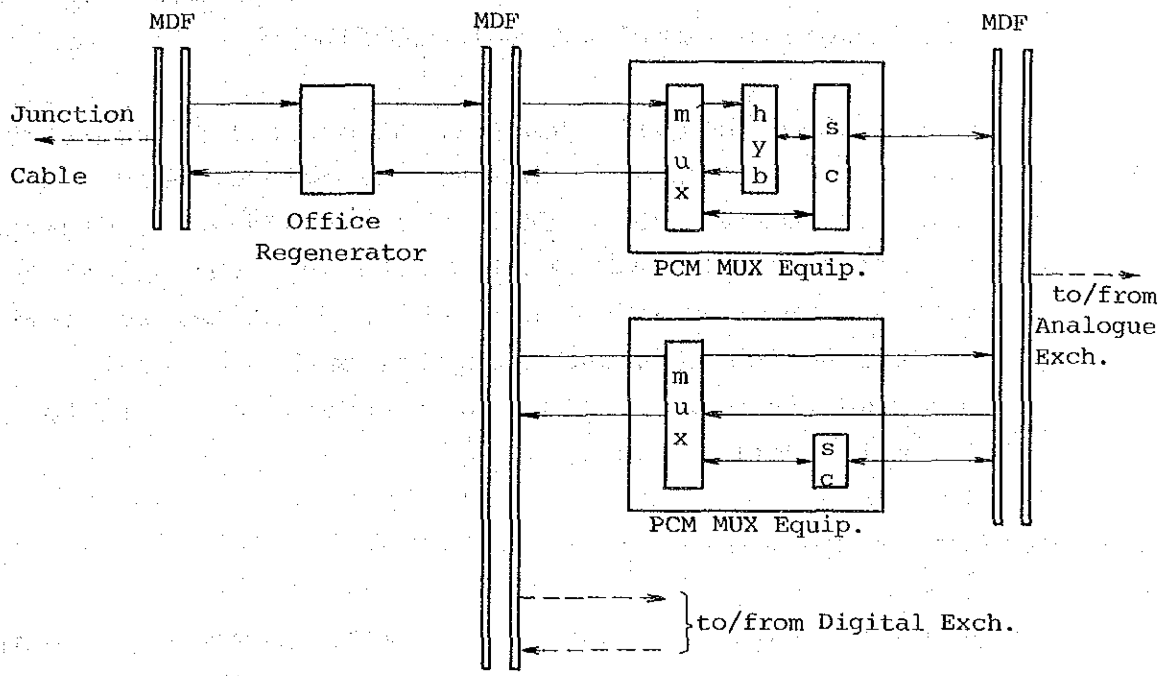
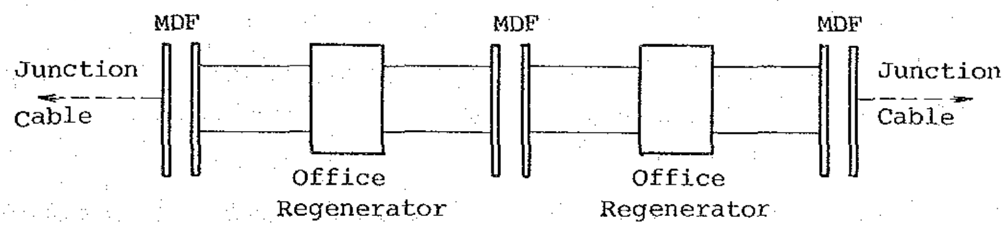


Figure 7-5 Provision of PCM Standby System

(1) Terminal Exchange



(2) Intermediate Exchange



Legend mux : PCM Multiplexer
hyb : 2W/4W Terminating Set
sc : Signalling Converter

Figure 7-6 Typical Wiring Arrangement for PCM System

7-1-2 Optical Fiber Cable System

Optical fiber cable system converts digital electric signal to digital optical signal and transmits high speed digital signal via optical fiber.

This system basically consists of optical transmitter and optical receiver. Optical transmitter holds function to convert digital electric signal to digital optical signal and send out digital optical signal to transmission media (optical fiber). Optical receiver holds function to convert digital optical signal received via optical fiber as transmission media to digital electric signal.

7-1-2-1 System Outline

In this study, considering system performance scale in objective areas, optical fiber cable system having transmission speed of 34 Mbit/s is used as standard system. This standard system configuration is in Figure 7-7.

Functions of all kinds of equipment as system components are described below.

(1) Primary group PCM multiplex equipment (called 2M PCM MUX) holds function to convert 30 analog voice speech channels to one digital primary group (2048 Kbit/s) by PCM conversion and multiplexing, and vice versa.

This equipment is provided with built-in signal converter capable of signalling interface.

(2) Secondary group digital multiplex equipment (called 8M MUX) holds function to convert four digital primary groups received from primary group PCM multiplex equipment to one digital secondary group (8448 Kbit/s) by multiplexing, and vice versa.

(3) Tertiary group digital multiplex equipment (called 34M MUX) holds function to convert four digital secondary groups received from secondary group digital multiplex equipment to one digital tertiary group (34368 Kbit/s) by multiplexing, and vice versa.

(4) 34M optical fiber terminal equipment holds function to convert 34368 Kbit/s digital electric signal received from tertiary digital multiplex equipment to digital optical signal and send out this optical signal to optical fiber cable, and vice versa.

(5) For improvement of reliability of junction network in big three cities, line protection switchover equipment (LP SW) is introduced in addition to above-mentioned equipment categories. LP SW consists of N-number working optical fiber systems and one standby system so that when any one out of N-number working systems becomes faulty, such faulty system is automatically changed over to standby system. Order of changeover priority can be designated in advance according to degree of importance of each system, and this fact contributes to network reliability in case of system failure.

7-1-2-2 Bit Error Objective

In this study, objective value of bit error rate per repeating is set at 1×10^{-11}.

7-1-2-3 Repeater Spacing

Repeater spacing is obtained by

$$\sum_{i=1}^{m} a_i \cdot L_i + a_s \cdot n + a \leq (P_s - P_r) - (M_e + M_c)$$

where

a_i: i-th optical fiber attenuation (dB/km)

L_i: i-th optical fiber length (km)

m: Number of connected optical fibers

a_s: Mean value of optical fiber connection loss (dB)

n: Number of connection points

a: Intra-office loss including optical fiber connection loss and connector loss (dB)

P_s: Mean optical sending power (dBm)

P_r: Minimum optical receiving power as required for securing allowable bit error rate (dBm)

M_e: Equipment margin (dB)
This includes change with time and deterioration due to environmental conditions.

M_c: Line margin (dB)
This includes change with time and deterioration due to environmental conditions, as well as loss increment resulting from cable length extension due to cable route alteration.

Repeater spacing calculation by main parameters follows:

Parameters used and their values are

$P_s = -2$ dBm	$P_r = -41.5$ dBm
$a = 4$ dB	$M_e = 5$ dB
$M_c = 4$ dB	$a_i = 1$ dB/km (at wavelength of 1,300 nm)
$a_s = 0.3$ dB	

Assume that standard piece length of optical fiber cable is 1 km. Then, at distance of L km, number of connection points (n) is (L + 1). Therefore, connection loss of L km cable is $a_s \times (L + 1)$ and overall attenuation (left side of the foregoing equation) can be expressed as

$$a_i \cdot L + a_s(L + 1) + a$$

Therefore, repeater spacing is

$$L \leqq 20.1 \text{ km}$$

Prerequisite to this repeater spacing is to use GI type optical fiber in whose case applicable frequency bandwidth is about 800 MHz.km or more.

In the objective areas of this study, inter-exchange junction line length is less than 20 km in all cases. Hence no need for regenerative repeater.

7-1-2-4 Optical Fiber Cable Specifications

(1) Cable Type

Standard type is jelly filled, laminate sheathed optical fiber cable to be installed in conduit.

(2) Optical Fiber

GI type multi-mode optical fiber is used. Out of two types, i.e., high grade type and low grade type, whichever suitable for each section length is chosen in due consideration of cost required.

(3) Number of Cores

Number of optical fiber cores and intersticial conductors are as under.

No. of Optical Fiber Cores	Intersticial Conductors: No. of Conductors	Intersticial Conductors: Conductor Diameter (mm)
2	4	0.9
4	4	0.9
6	4	0.9
8	4	0.9
10	4	0.9
12	4	0.9
14	4	0.9
16	4	0.9

(4) Transmission Characteristics

Optical fiber transmission characteristics are as under.

a) Attenuation

High grade type	< 1.0 dB/km
Low grade type	1.0 - 1.5 dB/km

b) Frequency bandwidth

High grade type	> 800 MHz.km
Low grade type	600 - 800 MHz.km

c) Applicable wavelength

1300 mm

7-1-2-5 Transmission Line Protection

For purpose of optical fiber cable system reliability improvement, line protection switchover system, i.e., a system to change over faulty system in optical transmission section to normal system, is adopted. Line protection switchover system configuration is in Figure 7-8.

Line protection switchover system consists of N-number working systems and one standby system. If any one working system becomes faulty, such faulty system is automatically changed over to standby system.

7-1-2-6 Maintenance Order Wire Circuit

For maintenance order wire circuits that connect each two terminal exchange and connect terminal exchange and regenerative repeater in manhole, two types are required. They are

i) 2-wire ringdown circuit
ii) 4-wire loudspeaker circuit

2-wire ringdown circuit is established between terminal exchanges. This circuit is connected in series to order wire terminals in each repeater housing on the route. For call to terminal exchange from each repeater location on the route, 25 Hz signal of portable telephone is sent out from order wire terminals.

4-wire loudspeaker circuit connects all terminal exchanges. This circuit constitutes general calling system that calls all terminal exchanges simultaneously.

These two types of circuits, i.e., 2-wire circuit and 4-wire circuit, are combined to make maintenance order wire network.

7-1-2-7 Signal Conversion

For PCM multiplex equipment and analog switching equipment interface, signal conversion to make channel associated signals of PCM circuit conform to switching equipment specifications is indispensable. Converter for such signal conversion is usually mounted on PCM multiplex equipment.

7-1-2-8 Equipment Configuration and Wiring System

Block diagram of terminal exchange equipment configuration and wiring system is in Figure 7-9.

Digital distributing frame (DDF) to be established for each hierarchy as shown in Figure 7-9 is necessary to facilitate maintenance work, such as faulty system changeover and circuit test.

7-1-2-9 Equipment Location

Equipment should preferably be installed in room located near MDF and appropriately furnished for dust-proofing.

In some existing telephone exchanges in three objective cities, equipment room can be obtained near MDF; however, in other exchanges, building remodelling or annex is necessary. Floor space should be large enough for installation of all equipment commensurate with the number of systems in operation by final project year.

7-1-2-10 Power Supply to Equipment

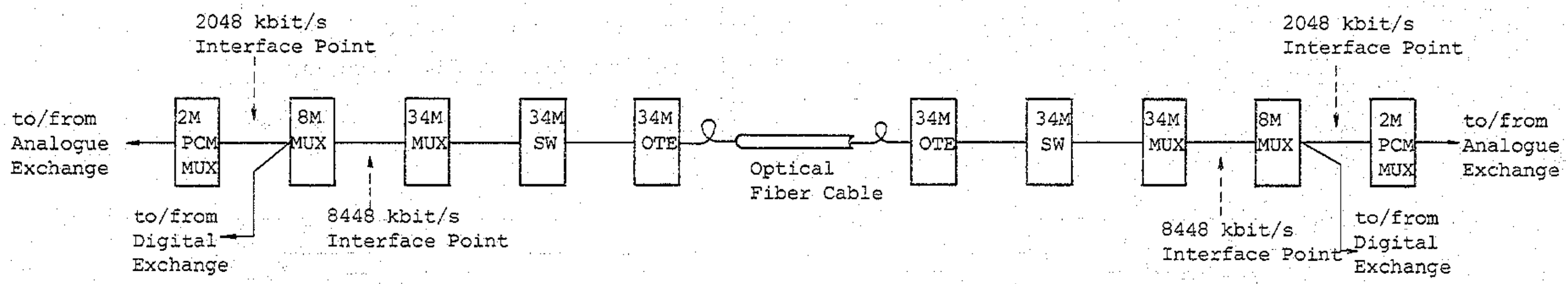
Required power for all kinds of equipment to be installed is supplied from d.c. -48 V or d.c. -60 V power source for switching equipment. This means that power supply equipment capacity must be large enough to cater completely for power consumption by switching equipment and optical fiber transmission equipment. In case where power supply equipment capacity falls short of above requirement, separate power supply equipment for optical fiber transmission equipment should be established.

7-1-3 Remote Supervision

That transmission system performance in junction network can be supervised at all times is indispensable for maintenance.

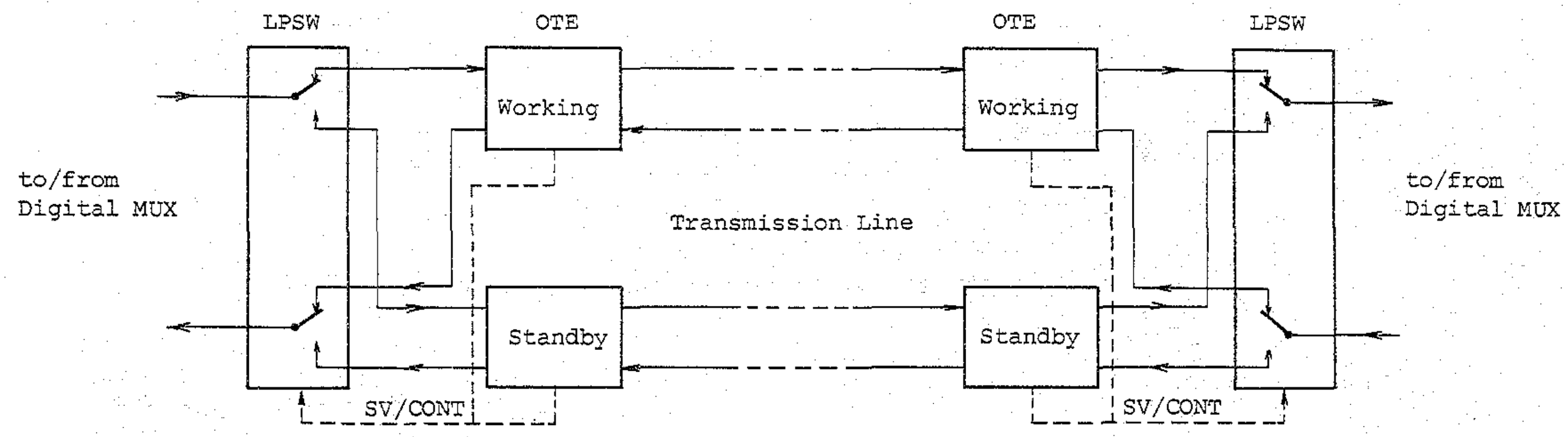
Supervisory systems are mainly twofold. One is remote centralized supervision system. The other is individual supervision system. The former is for centralized supervision of all systems in the whole network at one supervisory station. The latter is for separate supervision at each terminal exchange or for each transmission route.

For junction network wherein operation is on large scale and configuration is complicated, remote centralized supervision at one supervisory station is preferable.



Legend		
	2M PCM MUX	2048 kbit/s PCM Multiplex Equipment
	8M MUX	8448 kbit/s Digital Multiplex Equipment
	34M MUX	34368 kbit/s Digital Multiplex Equipment
	34M SW	Line Protection Switch
	34M OTE	34 Mbit/s Optical Fiber Terminal Equipment

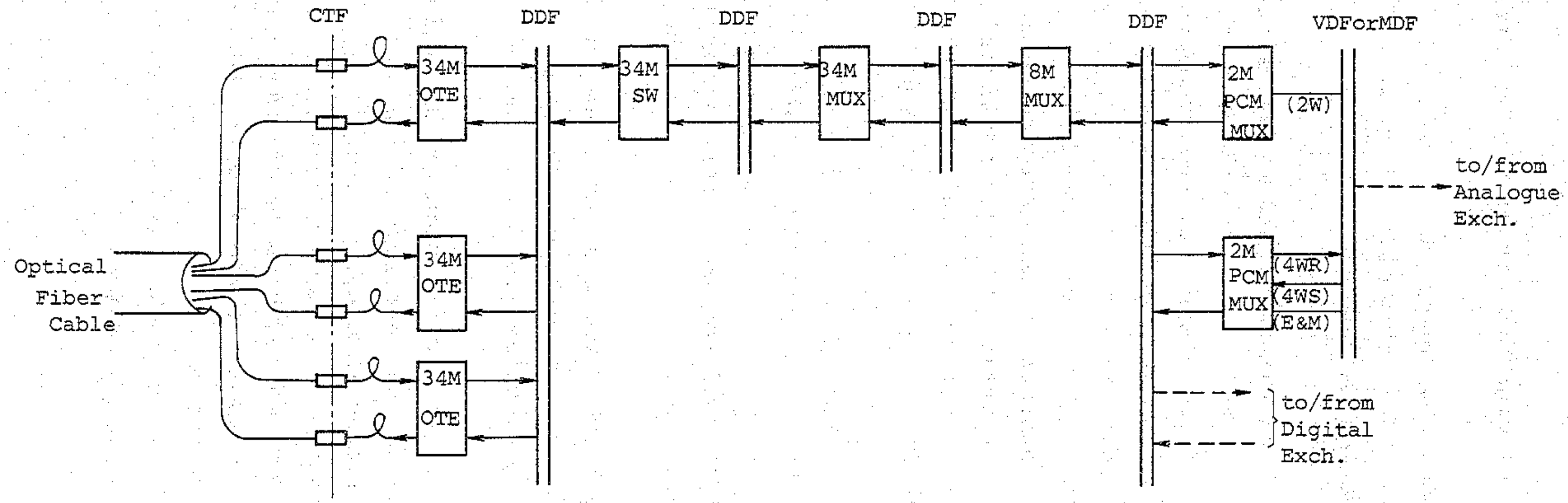
Figure 7-7 System Configuration for Optical Fiber Transmission (OF-34M)



Legend

SV/CONT: Supervisory and Control Signals

Figure 7-8 Line Protection Switchover System



Note : CTF = Optical Fiber Cable Terminating Frame

Figure 7-9 Typical Wiring Arrangement of Optical Fiber Transmission Terminal (OF-34M)

7-2 Junction Cable, Underground Conduit Design Standards

7-2-1 Underground Conduit Design

(1) Route Selection

Underground conduit route selection is made, based on field survey findings, as well as city planning and related data. Technical requirements from construction and maintenance angles are also taken into full consideration.

When newly constructing underground conduit facilities, attention to under-mentioned requirements is especially important for optimum route selection.

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

2) To select road not to be rebuilt or disused by city planning, etc.

3) To select road where river crossings (including routing by bridge attachment) and railway crossings are few.

4) To select road where underground structures are few so that underground conduit construction is easy.

5) To select road of broad width where surface traffic seldom interferes with underground conduit construction.

6) To select unpaved road.

(2) Number of Conduit Lines

Number of underground conduit lines required for junction cable accommodation is determined pursuant to number of junction cable lines required by long term plan, as well as Chapter 6, Section 6.1 Design Standards for Subscriber Cable Network and Underground Conduit Facilities.

(3) Manhole and Handhole

Manhole and handhole are established at cable connection point and PCM regenerative repeater location.

Manhole and handhole types and dimensions are determined pursuant to Chapter 6, Section 6.1 Design Standards for Subscriber Cable Network and Underground Conduit Facilities.

7-2-2 Junction Cable

Junction cable to be used conforms to PERUMTEL's standard cable specifications, in principle. Type, pairs and conductor diameter of cable are as under.

(1) Cable Type

For junction cable, PE-sheathed and insulated, quadded, internally screened and jelly filled cable is used, in principle.

This cable is for PCM transmission system. Not only can all cable conductors be used for PCM transmission but can repeater spacing be established at longer distance than by ordinary cable (for voice transmission). The latter merit is from superior electric characteristics.

Steel tape armored cable is used in such cases as undermentioned.

1) Where cable re-location due to road rebuilding or river improvement is foreseen;

2) Where underground conduit is inappropriate because road planning remains undecided.

(2) Cable Pairs

Cable pairs of junction cable are in Table 7-1.

(3) Electric Characteristics

d.c. loop resistance and attenuation constant at 800 Hz classified by conductor diameter are in Table 7-2.

Table 7-1 Conductor Diameter and Cable Pairs

Conductor Diameter (mm)	Number of Cable Pairs
0.6	20, 40, 80, 100, 200
0.8	20, 40, 80, 100, 200

Table 7-2 Loop Resistance and Attenuation Constant

Conductor Diameter (mm)	Loop Resistance (ohm/km)	Attenuation at Constant 800 Hz (dB/km)
		Non-loaded
0.6	130	1.11
0.8	73	0.87

7-3 Basic Design Items and Preconditions

7-3-1 Junction Cable Route Selection

Junction cable route selection guidelines are as under.

- To carry out field survey with plan to utilize existing underground conduit facilities, if possible, and to study technical requirements concerning construction and related affairs.

- To make most effective utilization of idle ducts, if available, in existing underground conduits having sufficient capacity for additional subscriber cable and junction cable installation.

- In case where idle ducts with capacity for cable expansion are not available in existing underground conduits, to decide whether to carry out underground conduit expansion on existing route or to construct alternative underground conduit on new route, in careful consideration of manhole capacity and alternative conduit route availability.

In such cases as undermentioned, utilization of existing underground conduit route is economically advantageous.

(1) Where number of cable lines to be newly installed is relatively small;

(2) Where existing manhole capacity is relatively large so that conduit expansion by necessary number of ducts does not necessitate manhole remodelling.

Selection of new underground conduit route holds such advantages as under.

(1) Manhole location can be freely chosen on junction cable route in accordance with typical PCM repeater spacing design.

(2) Manhole design and construction, wherein PCM regenerative repeater accommodation is duly considered, are possible.

(3) When new junction cable route is established in addition to existing route, transmission route diversification results. This not only leads to network reliability improvement but also creates adaptability to demand fluctuation.

As for junction cable route to new exchange, several conceivable routes are first selected and, after comparative study of those route from technical and economic angles, final selection is made for optimum route in all respects.

In addition to the foregoing two plans (i.e., to utilize existing conduit route and to establish new conduit route), subscriber cable expansion plan is also taken into consideration so as to determine final plan.

7-3-2 Design Preconditions

Junction cable network basic design primarily follows Chapter 7, Section 7-2 Junction Cable, Underground Conduit Design Standards. Design conforms to undermentioned preconditions also.

(1) Newly installed cable pairs be commensurate with estimated circuit demand as of 1998.

(2) Manhole where to install PCM regenerative repeater be of capacity commensurate with estimated number of repeater housings as of 2005.

(3) Number of junction cable duct lines be commensurate with estimated number of cables as of 1998. One spare duct be reserved for additional junction cable or optical fiber cable installation in 1998 or after.

(4) Quantity of digital transmission equipment be commensurate with estimated circuit demand as of 1993.

(5) PCM regenerative repeater housing be of capacity to accommodate 36 regenerative repeaters at maximum.

7-4 Transmission System Basic Design

7-4-1 Applicable System Selection

In accordance with REPELITA IV digital switching equipment introduction plan, digital transmission system is introduced. Digital transmission system is compatible with digital switching equipment and its introduction is economically advantageous.

Study based on circuit grouping result shows that for applicable transmission system, 2 Mbit/s digital transmission system that uses metallic cable is qualified. Therefore, this system is selected.

The selection is resulted from comparative study of 34 Mbit/s (480 CH/system) system for optical fiber cable system and 2 Mbit/s (30 CH/system) system for metallic cable system, both chosen from required circuit group size. In-depth details of comparative study are in ANNEX 4.

7-4-2 Transmission Line Plan

Accommodation results of required circuits as of 1993, 1998 and 2005 in 2 Mbit/s metallic cable system, based on Chapter 4, Section 4.6 Circuit Grouping, are in Figure 7-10 (1/6 - 6/6).

7-4-3 Basic Design

(1) Transmission Facilities

Transmission facilities design is made by design standards described in Chapter 7, Section 7-1-1 PCM Cable System, based on cable pairs to meet required number of circuits as of 1998. Repeater spacing design and power supply system design results are in Figures 7-11 (1/2) and (2/2) and Figures 7-12 (1/2) and (2/2), respectively.

For remote supervision system, centralized supervision system is adopted. Centralized supervisory station for Medan area is established in Centrum II Exchange, for Semarang area in Semarang I Exchange and for Solo area in Solo I Exchange. In these exchange premises, transmission/radio terminal stations exist with transmission facilities maintenance staffs assigned. This fact presents technical environment that enables centralized supervisory stations to function as required.

(2) Power Supply Facilities and Building Space

1) Power Supply Facilities

This time, project coverage areas are urban areas so that stable commercial power supply is available. Thus, for power supply system to transmission facilities, full floating system which can do with small storage battery capacity and which can keep storage battery life long is adopted.

Initial capacity is to meet with power requirement for 10 years after service-in, i.e., as of 1998. Design is by undermentioned standards. Meanwhile, exchange by exchange power consumption whereby to determine power supply system capacity is in ANNEX 5.

a) Storage Battery

- Holding time: 10 hours
- Required capacity be divided into two, to be covered by two storage battery units.
- Lead storage battery be used, each unit composed of 24 cells.

b) Rectifier

- Rectifier be composed of two units.
- Each rectifier unit be of capacity to supply load current and 10-hour charging current for two storage battery units.

2) Building

Building space for transmission facilities and power supply facilities is classified as under.

a) Building Space for Transmission Facilities

Type A: 6 m x 7 m

Type B: 6 m x 3.5 m

Type C: 3 m x 3.5 m

Building type classification by exchange follows:

Type A: Centrum II

Type B: Centrum I, Pulau Brayan, Semarang I, Semarang II

Type C: Tugu, other exchanges

b) Building Space for Power Supply Facilities

Type Y: 6 m x 7 m

Type Z: 6 m x 3.5 m

Building type classification by exchange follows:

Type Y: Centrum II

Type Z: Other exchange

Typical transmission equipment floor layout is in Figure 7-13.

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

Circuit	'93	'98	'05		'93	'98	'05	
	7	11	15		7	11	15	
(TDM)	3	3	3		3	3	3	
(11X)	1	1	1		1	1	1	
②	3	3	3		3	3	3	
③	4	4	5		4	4	5	
④	4	4	5		4	4	5	
(SLDD)	5	9	14		5	9	14	
(10X)	1	2	2		1	2	2	
(NT)	2	3	4		2	3	4	A
⑦	4	6	10		4	6	10	
⑪	2	2	5		2	2	5	
⑫	—	2	2		—	2	2	
⑭	—	—	2		—	—	2	
⑧	2	3	5		2	3	5	
⑨	3	6	9		3	6	9	
⑬	—	—	4		—	—	4	
	3	6	9	⑩ ⑩	2	4	8	
(TDM)	3	3	3	"				
(11X)	1	1	1	"				
②	—	2	2	"				
③	2	2	3	"				
④	2	2	3	"				
(SLDD)	3	4	8	"				
(10X)	1	1	2	"				
(NT)	1	2	3	"				
⑧	—	2	3	"				
⑨	1	3	5	"				
⑬	—	—	2	"				
⑦	2	3	7	"				
⑪	—	—	3	"				
⑭	—	—	2	"				
	1	1	1		1	1	1	HS
HS	1	1	1	⑩ ⑩	1	1	1	HS
TOTAL	62	92	147		45	65	99	

SIMPANG LIMUN ⑩ [D] (jl)

Circuit	'93	'98	'05	
⑤	3	6	9	
(TDM)	3	3	3	
(11X)	1	1	1	
②	—	2	2	
③	2	2	3	
④	2	2	3	
(SLDD)	3	4	8	
(10X)	1	1	2	
(NT)	1	2	3	A
⑧	—	2	3	
⑨	1	3	5	
⑬	—	—	2	
⑦	2	3	7	
⑪	—	—	3	
⑭	—	—	2	
⑥	2	4	8	
"	1	1	1	HS
⑤	1	1	1	HS
TOTAL	23	37	66	

Legend

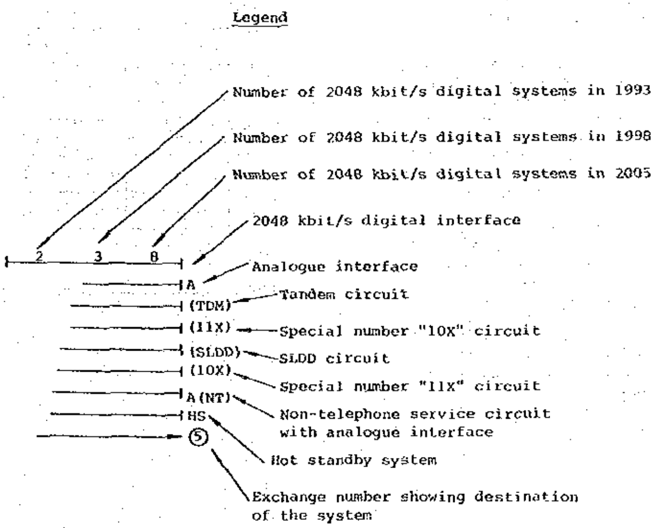


Figure 7-10 (1/6) 2 Mb/s Cable System Plan (Medan)

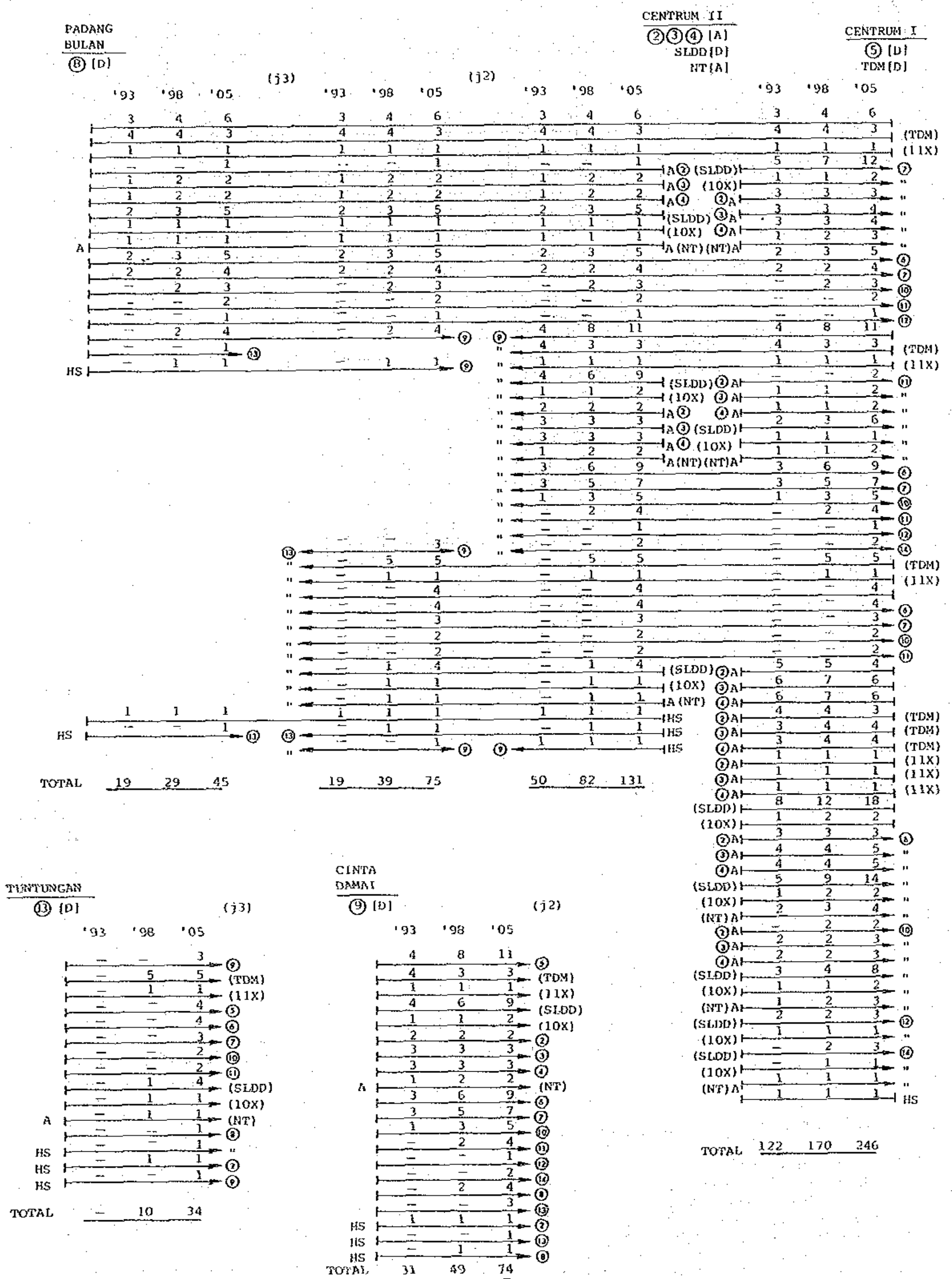


Figure 7-10 (2/6) 2 Mb/s Cable System Plan (Medan)

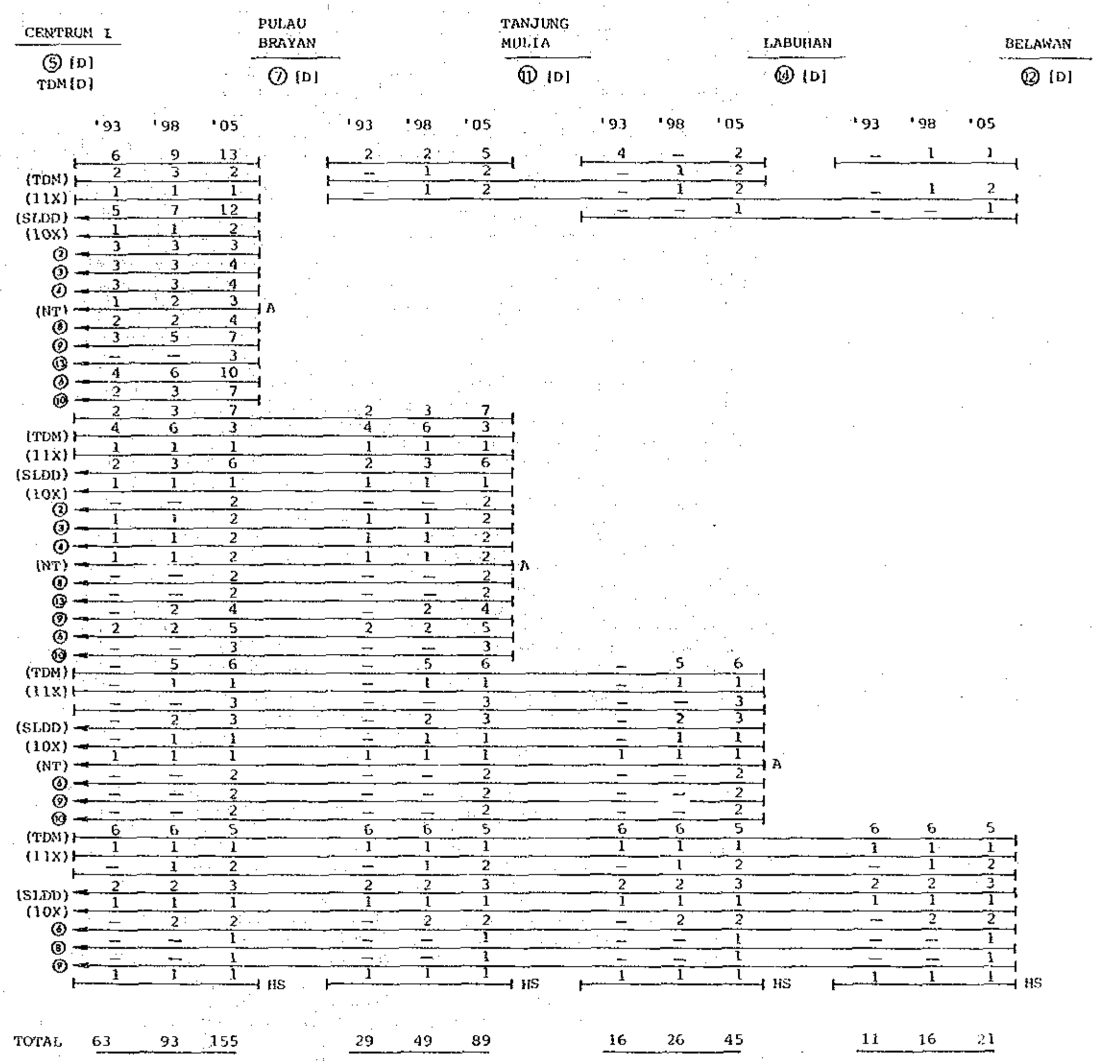


Figure 7-10 (3/6) 2 Mb/s Cable System Plan (Medan)

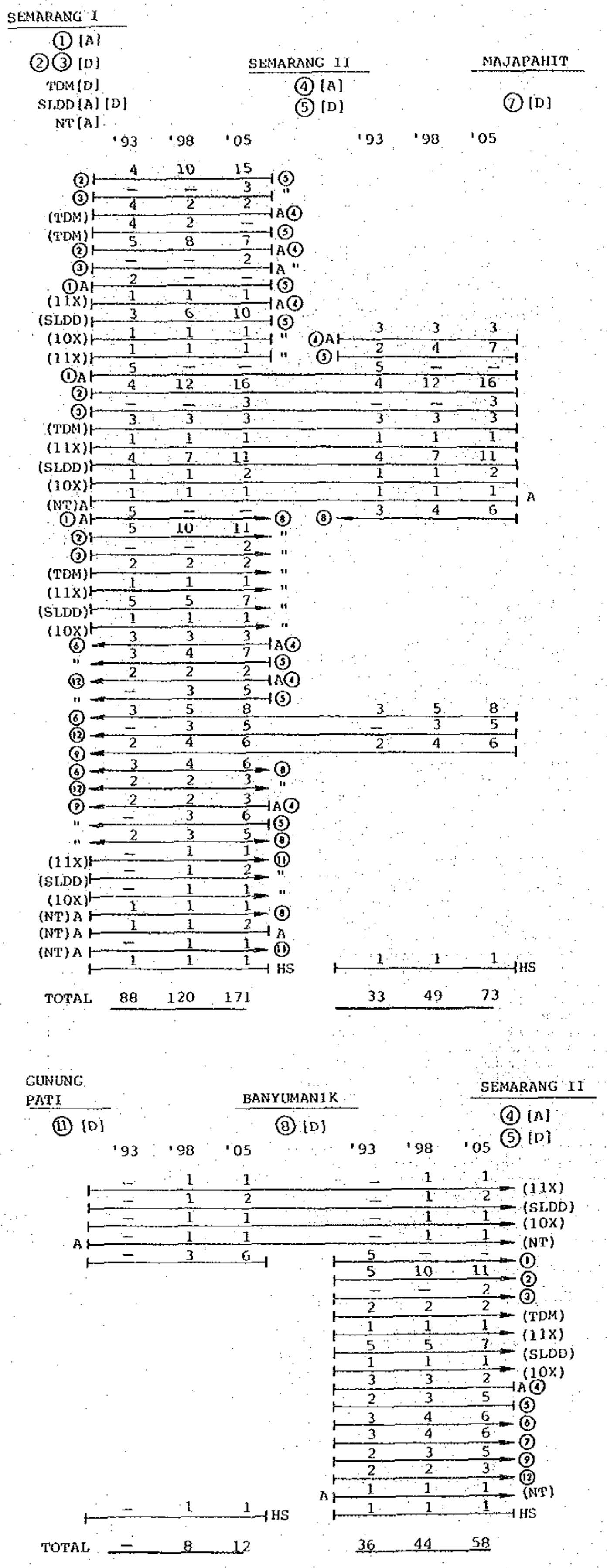
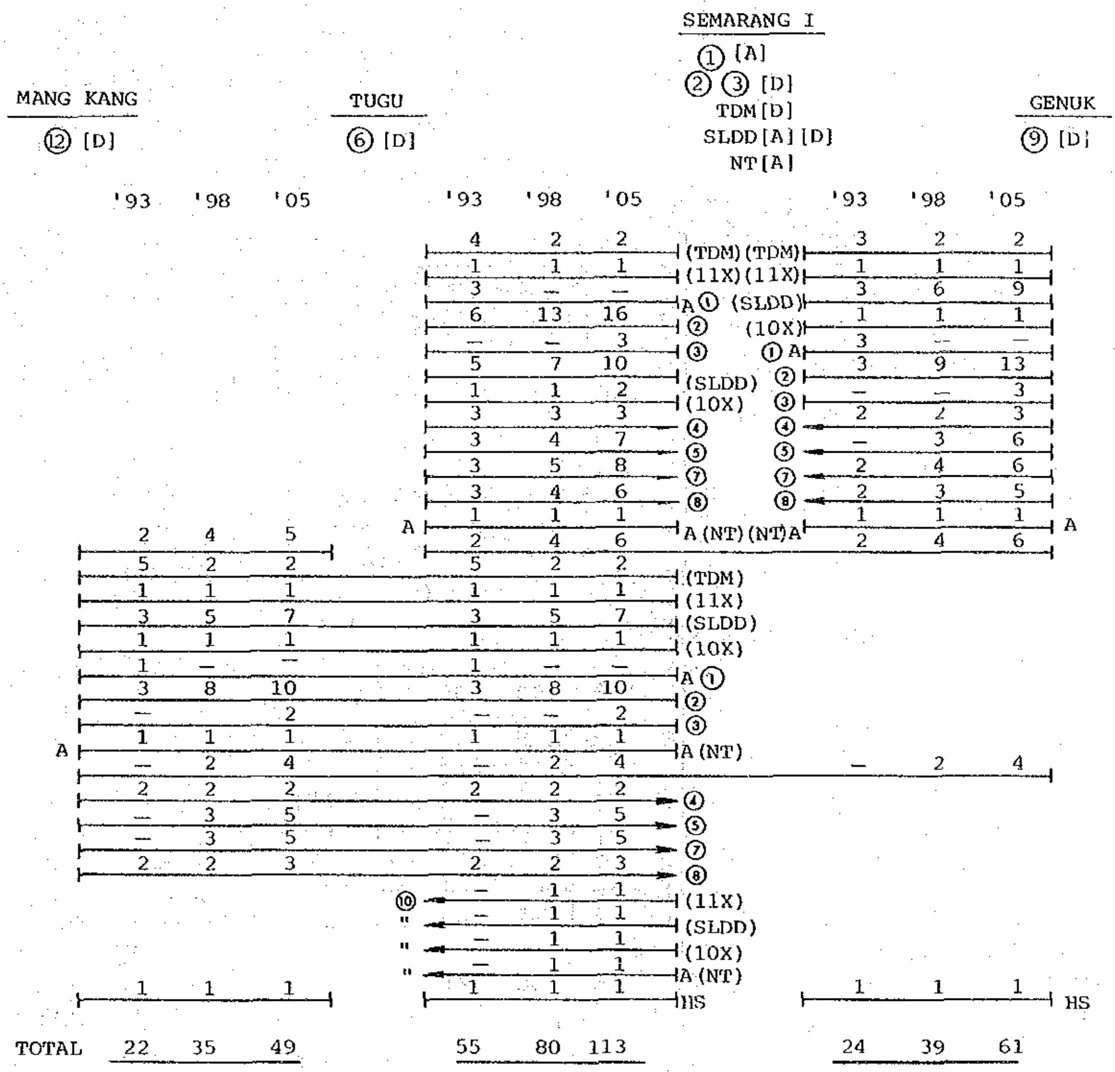


Figure 7-10 (4/6) 2 Mb/s Cable System Plan (Semarang)



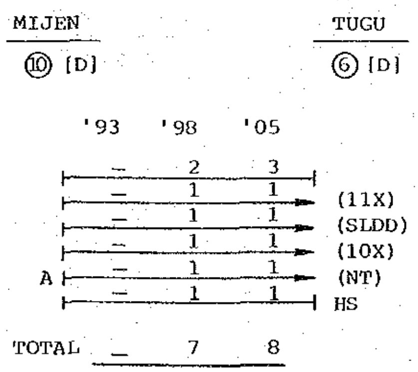


Figure 7-10 (5/6) 2 Mb/s Cable System Plan (Semarang)

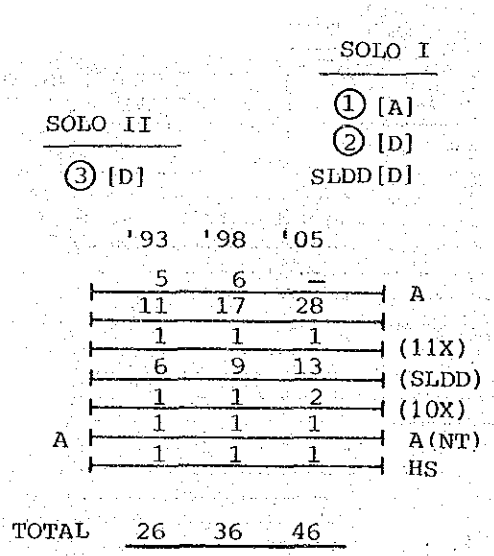


Figure 7-10 (6/6) 2 Mb/s Cable System Plan (Solo)

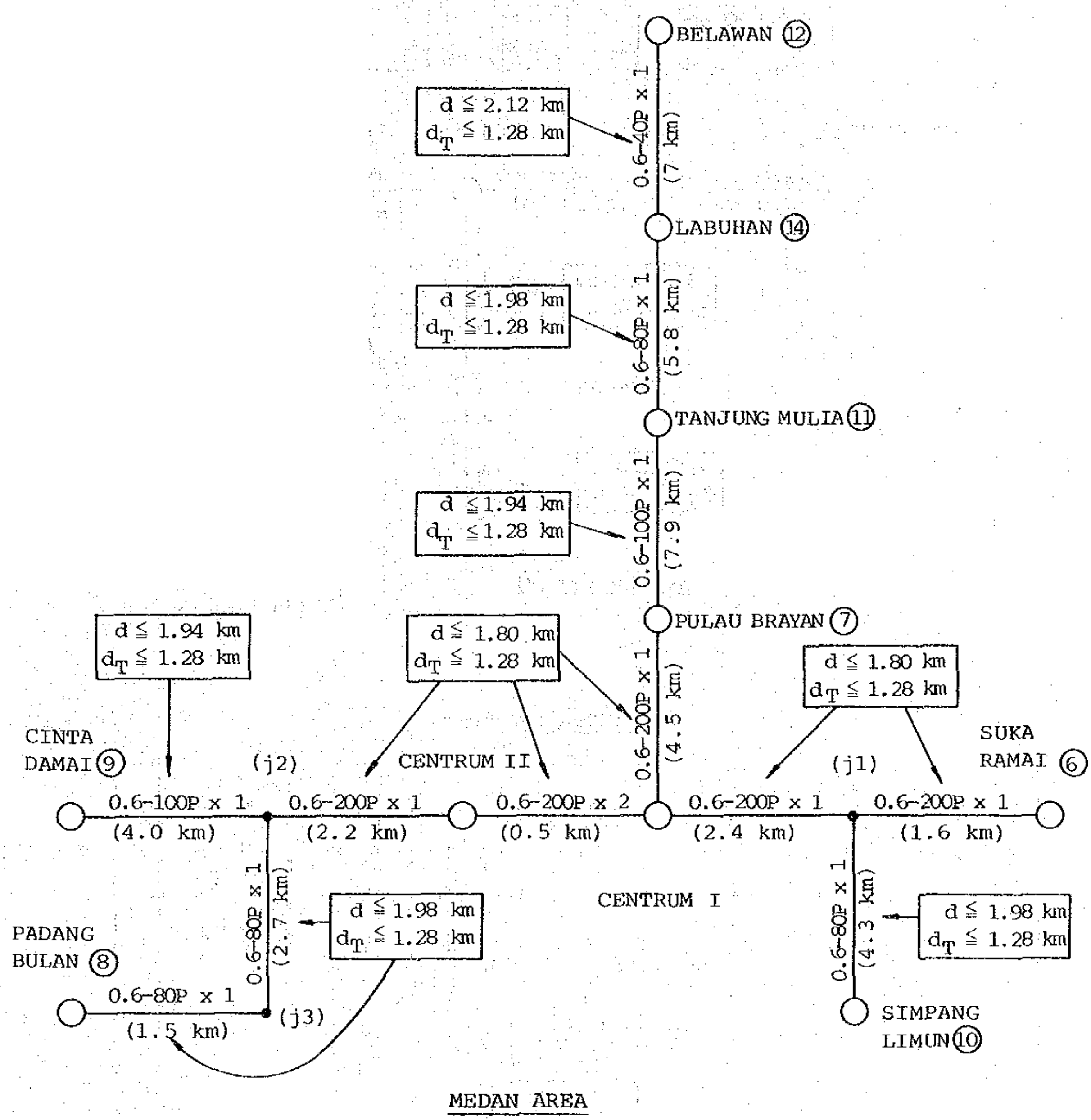
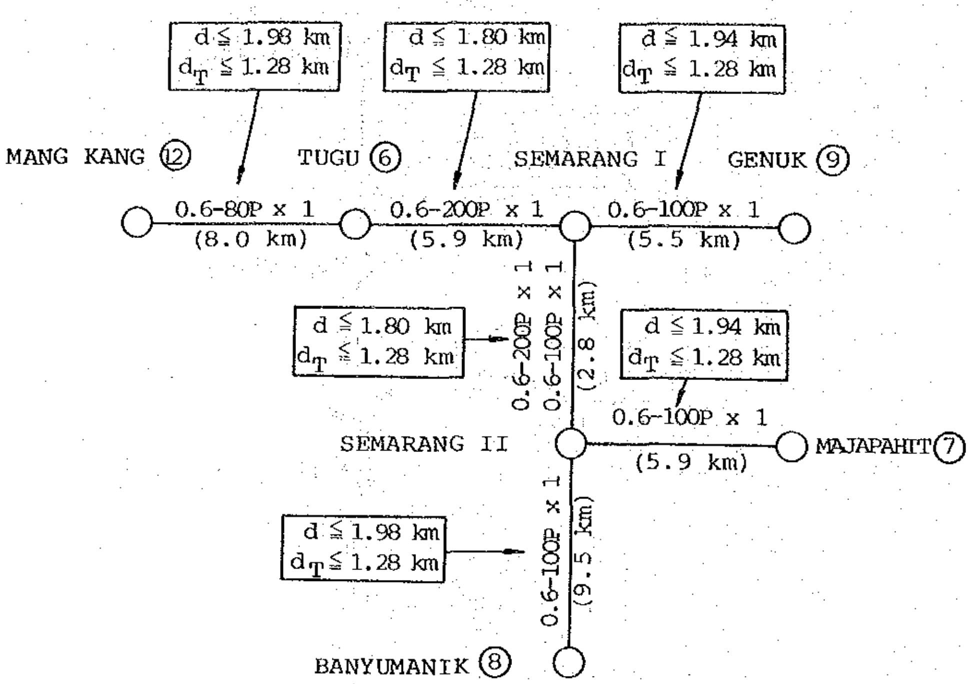
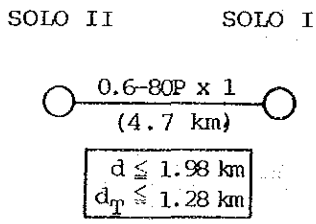


Figure 7-11 (1/2) Regenerator Spacing Design (Medan)

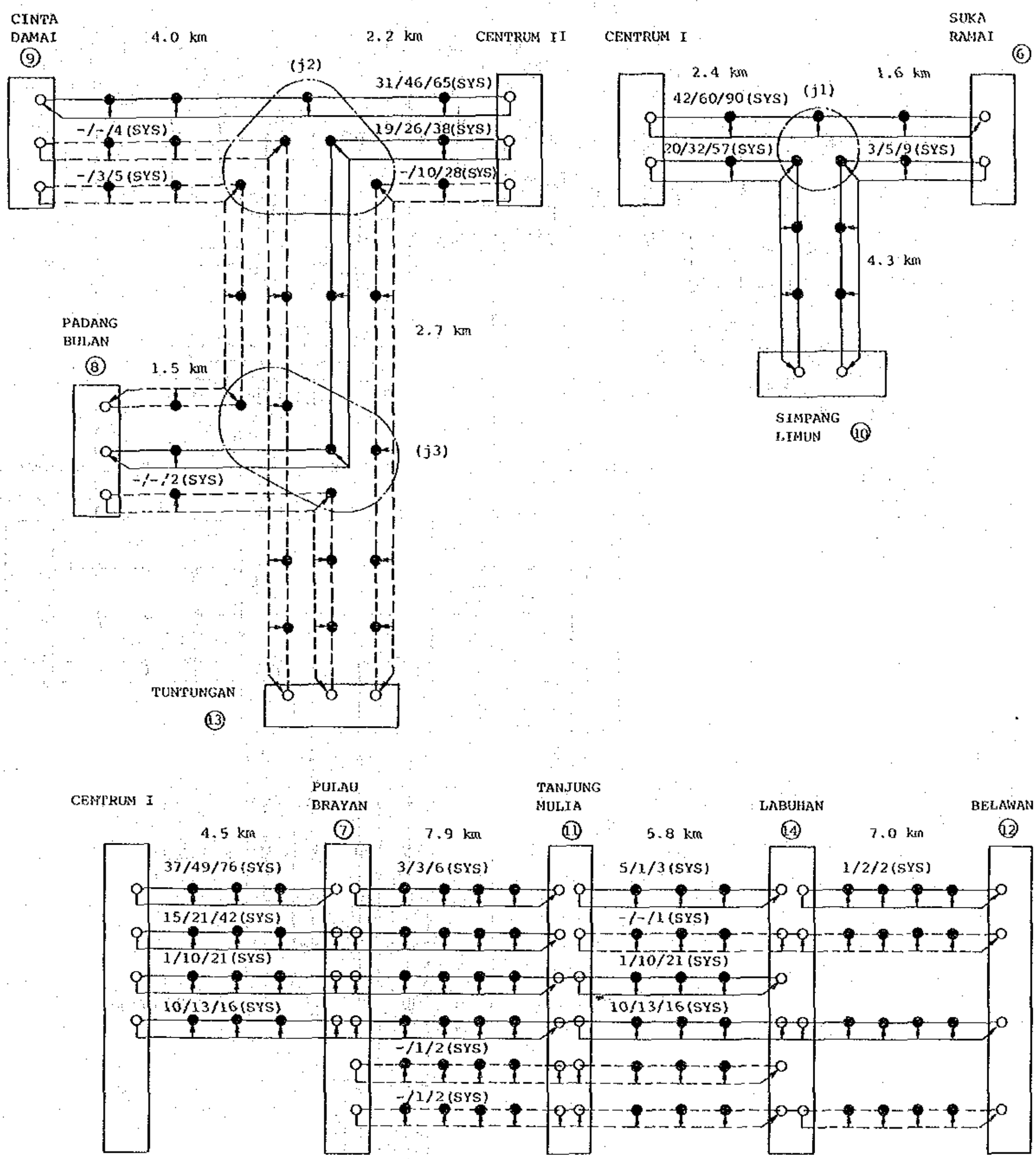


SEMARANG AREA

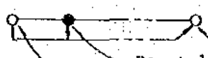


SOLO AREA

Figure 7-11 (2/2) Regenerator Spacing Design (Semarang, Solo)



LEGEND 42/60/90(SYS): Number of PCM systems in 1993, 1998 nad 2005



The system represented by dotted lines means a system to be installed in future.

Figure 7-12 (1/2) Power Feeding System Design (Medan)

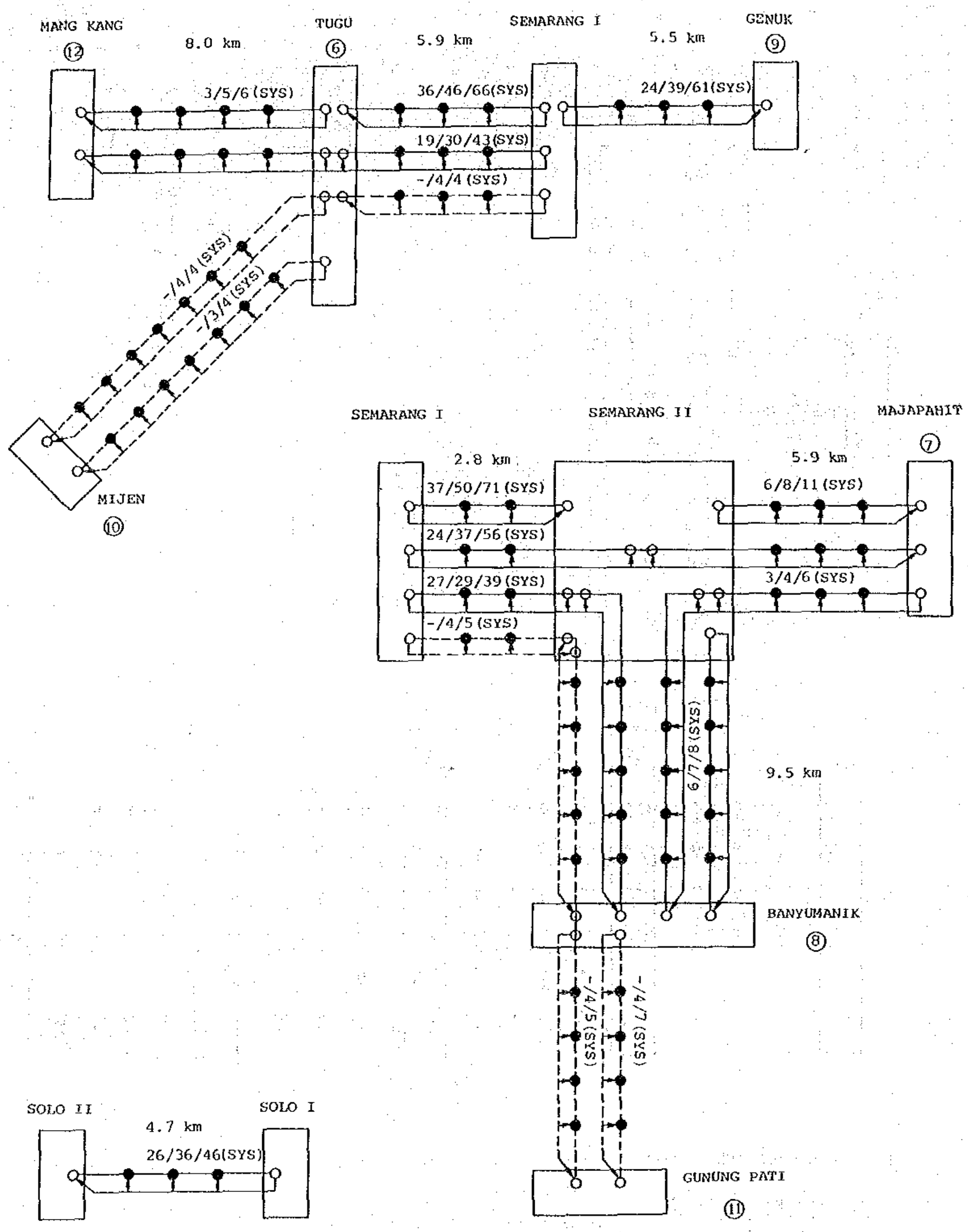


Figure 7-12 (2/2) Power Feeding System Design (Semarang, Solo)

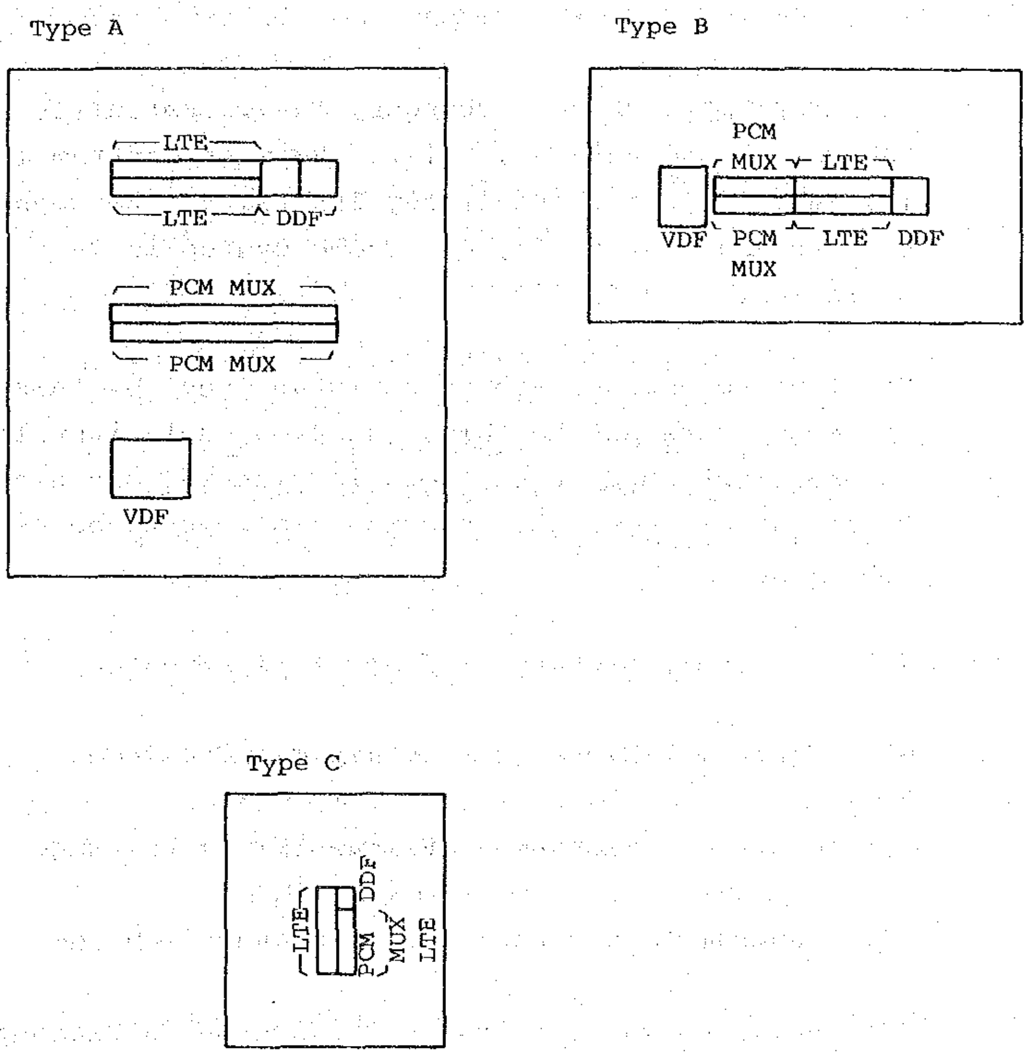


Figure 7-13 Typical Transmission Equipment Floor Layout

7-5 Junction Cable Basic Design

7-5-1 Medan Area

In Medan City, three exchanges, i.e., Centrum I, Centrum II and Belawan, exist. Between Centrum I and II, junction cable is already installed. Between Belawan and Centrum II, UHF radio system is in operation.

Eight new exchanges are to be established by this project. Pursuant to this, junction cable installation in undermentioned 10 sections is planned. In nine sections out of those 10, junction cable is to be newly installed.

(1) Centrum I Exchange - Centrum II Exchange

(2) Centrum I Exchange - Suka Ramai Exchange

(3) Centrum I Exchange - Simpang Limun Exchange

(4) Centrum I Exchange - Pulau Brayan Exchange

(5) Pulau Brayan Exchange - Tanjung Mulia Exchange

(6) Tanjung Mulia Exchange - Labuhan Exchange

(7) Labuhan Exchange - Belawan Exchange

(8) Centrum II Exchange - Cinta Damai Exchange

(9) Centrum II Exchange - Padang Bulan Exchange

(10) Padang Bulan Exchange - Tuntungan Exchange (subject to future plan)

Those junction cable routes are schematically presented in Figure 7-14. For route selection and underground conduit facilities, summary description is made below.

(1) Centrum I Exchange - Centrum II Exchange

Between these two exchanges, junction cable exists. However, in Centrum I Exchange neighborhood, no underground conduit facilities exist.

Pursuant to subscriber cable expansion, new underground conduit construction in Centrum I Exchange neighborhood and existing underground conduit expansion along Prof. Yaminsh Street are scheduled. Therefore, new junction cable route is chosen on the same route as existing cable route.

(2) Centrum I Exchange - Suka Ramai Exchange

Shortest junction cable route between these two exchanges is via Prof. Yaminsh Street and Sutrisno Street. Except for Suka Ramai Exchange neighborhood on Sutrisno Street, underground conduit facilities exist.

In this case, junction cable route constitutes main subscriber cable route. Therefore, pursuant to subscriber cable expansion, large scale underground conduit facilities expansion is scheduled.

(3) Centrum I Exchange - Simpang Limun Exchange

Shortest junction cable route between these two exchanges is via Sutomo Street and Laksana Street. This route is the same in part as junction route to Suka Ramai Exchange.

On Laksana Street, existing underground conduit extends to halfway to street and constitutes main subscriber cable route. Pursuant to subscriber cable expansion, large scale underground conduit facilities expansion is scheduled.

Junction cable from Centrum I Exchange branches, halfway on cable route, into two directions, one to Suka Ramai Exchange and the other to Simpang Limun Exchange.

(4) Centrum I Exchange - Pulau Brayan Exchange

Shortest junction cable route between these two exchanges is via Prof. Yaminsh Street and Krakatau Street. To halfway on this cable route from Centrum I Exchange, existing underground conduit extends.

This junction route constitutes main subscriber cable route. Pursuant to subscriber cable expansion, large scale underground conduit facilities expansion is scheduled.

(5) Pulau Brayan Exchange - Tanjung Mulia Exchange

Shortest junction cable route between these two exchanges is via Laksana Yos Sudarso Street. On this route, no underground conduit facilities exist.

This junction route constitutes main subscriber cable route. Pursuant to subscriber cable expansion, large scale underground conduit facilities expansion is scheduled.

(6) Tanjung Mulia Exchange - Labuhan Exchange

Shortest junction cable route between these two exchanges is via Laksana Yos Sudarso Street only. This route is without existing underground conduit facilities.

This junction route constitutes main subscriber cable route. Pursuant to subscriber cable expansion, large scale underground conduit facilities expansion is scheduled.

(7) Labuhan Exchange - Belawan Exchange

Shortest junction cable route between these two exchanges is via Laksana Yos Sudarso Street only. This route is without existing underground conduit facilities.

This junction route constitutes main subscriber cable route. Pursuant to subscriber cable expansion, large scale underground conduit facilities expansion is scheduled.

(8) Centrum II Exchange - Cinta Damai Exchange

Shortest junction cable route between these two exchanges is via Guru Patimpus Street and Gatot Subroto Street. To halfway on this route from Centrum II Exchange, existing underground conduit facilities extend.

This junction route constitutes main subscriber cable route. Pursuant to subscriber cable expansion, large scale underground conduit facilities expansion is scheduled.

(9) Centrum II Exchange - Padang Bulan Exchange

Shortest junction cable route between these two exchanges is via Guru Patimpus Street and Iskandar Mada Street. To halfway on this route from Centrum II Exchange, existing underground conduit facilities extend.

This junction route constitutes main subscriber cable route. Pursuant to subscriber cable expansion, large scale underground conduit facilities expansion is scheduled.

Junction cable from Centrum II Exchange branches, halfway on the route, into two directions, i.e., to Cinta Damai Exchange and to Padang Bulan Exchange.

(10) Padang Bulan Exchange - Tuntungan Exchange

Shortest junction cable route between these two exchanges is via Pattimura Street. This junction cable route is subject to future plan.

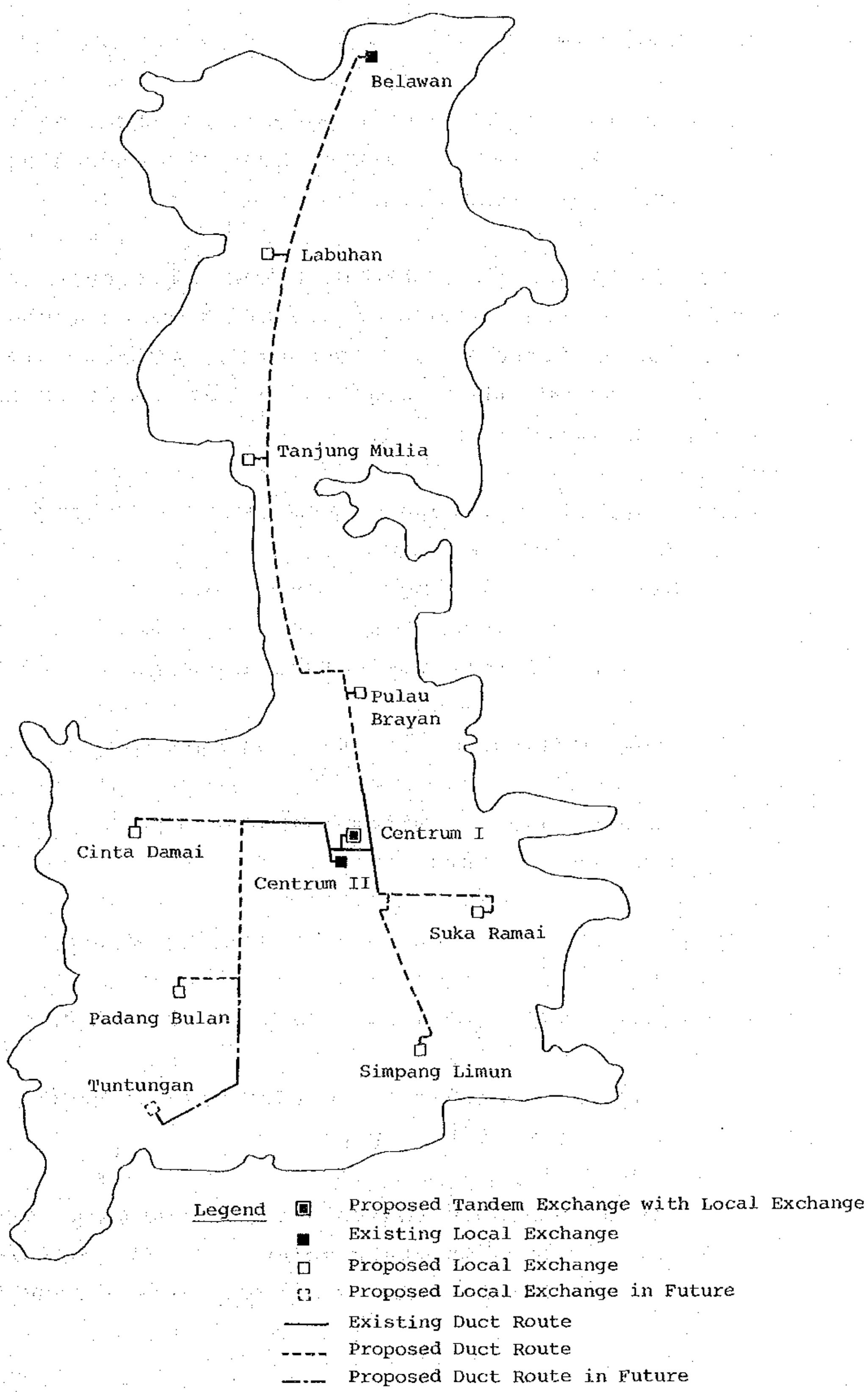


Figure 7-14 Junction Route Map (Medan)

7-5-2 Semarang Area

In Semarang City, two exchange, i.e., Semarang I and Semarang II, exist. Between these two exchanges, junction cable exists.

Five new exchanges are to be established by this project. Pursuant to this, junction cable installation in undermentioned eight sections is planned. In seven sections out of those eight, junction cable is to be newly installed.

(1) Semarang I Exchange - Semarang II Exchange

(2) Semarang I Exchange - Genuk Exchange

(3) Semarang I Exchange - Tugu Exchange

(4) Tugu Exchange - Mang Kang Exchange

(5) Tugu Exchange - Mijem Exchange
(subject to future plan)

(6) Semarang II Exchange - Majapahit Exchange

(7) Semarang II Exchange - Banyumanik Exchange

(8) Banyumanik Exchange - Gunung Pati Exchange
(subject to future plan)

These junction cable routes are schematically presented in Figure 7-15. For route selection and underground conduit facilities, summary description is made below.

(1) Semarang I Exchange - Semarang II Exchange

Between these two exchanges, underground conduit facilities and junction cable exist along Gajah Mata Street.

In view of new underground conduit facilities deconcentration for subscriber cable expansion, no change is made in junction cable route between two exchanges.

Decision is made not to carry out civil engineering work on existing underground conduit route specifically for junction cable installation.

(2) Semarang I Exchange - Genuk Exchange

Shortest junction cable route between these two exchanges is a route via Raden Patah Street only. At present, this street is without underground conduit facilities.

Raden Patah Street constitutes main subscriber cable route. Pursuant to subscriber cable expansion in both exchange areas, underground conduit facilities expansion is scheduled.

(3) Semarang I Exchange - Tugu Exchange

Shortest junction cable route between these two exchanges is a route via Siliwangi Street. This route is almost completely without underground conduit facilities.

REPELITA III plan includes subscriber cable expansion. Pursuant to this, underground conduit facilities expansion is scheduled in Semarang I Exchange area along new junction cable route.

In this project, new junction cable route constitutes main subscriber cable route of Tugu Exchange. Pursuant to subscriber cable expansion, underground conduit facilities expansion is scheduled along new junction cable route.

(4) Tugu Exchange - Mang Kang Exchange

Shortest junction cable route between these two exchanges is via Siliwangi Street, and this route is the sole route available. At present, this street is without underground conduit facilities.

Siliwangi Street constitutes main subscriber cable route. Underground conduit facilities expansion is scheduled along this street.

(5) Tugu Exchange - Mijen Exchange

Shortest junction cable route between these two exchanges is via Jerakah Tugu Street, and this route is the sole route available. At present, this street is without underground conduit facilities.

By this project, underground conduit facilities are newly constructed along Dr. Setia Budi Street and Jerakah Tugu Street. This route serves as future junction route between Tugu Exchange and Mijen Exchange.

(6) Semarang II Exchange - Majapahit Exchange

Shortest junction cable route between these two exchanges is via Majapahit Street, and this route is the sole route available. At present, this street is without underground conduit facilities.

According to REPELITA III work plan, underground conduit facilities are newly constructed to a point 1.5 km from Majapahit Exchange, wherein to install subscriber cable from Semarang II Exchange. This main underground conduit route is used as new junction route to Semarang II Exchange - Banyumanik Exchange section, and, pursuant to this, new underground conduit route is established in Majapahit Exchange area.

(7) Semarang II Exchange - Banyumanik Exchange

Shortest junction cable route between these two exchanges is via Dr. Setia Budi Street, and this route is the sole route available. In city center where this street extends, underground conduit facilities exist with subscriber cable from Semarang II Exchange installed therein.

According to REPELITA III work plan, underground conduit facilities are extended to Banyumanik Exchange, wherein to install subscriber cable from Semarang II Exchange. This main underground conduit route is used as new junction route to Semarang II Exchange - Banyumanik Exchange section so that at a point near Semarang II Exchange, manhole remodelling and conduit expansion pursuant subscriber cable expansion are carried out.

(8) Banyumanik Exchange - Gunung Pati Exchange

Sole existing junction cable route between these two exchanges extends to south along Dr. Setia Budi Street and then proceeds via periphery of both exchange areas.

City planning indicates road construction schedule traversing Banyumanik Exchange - Gunung Pati Exchange section. Decision is made to use this road as future junction cable route.

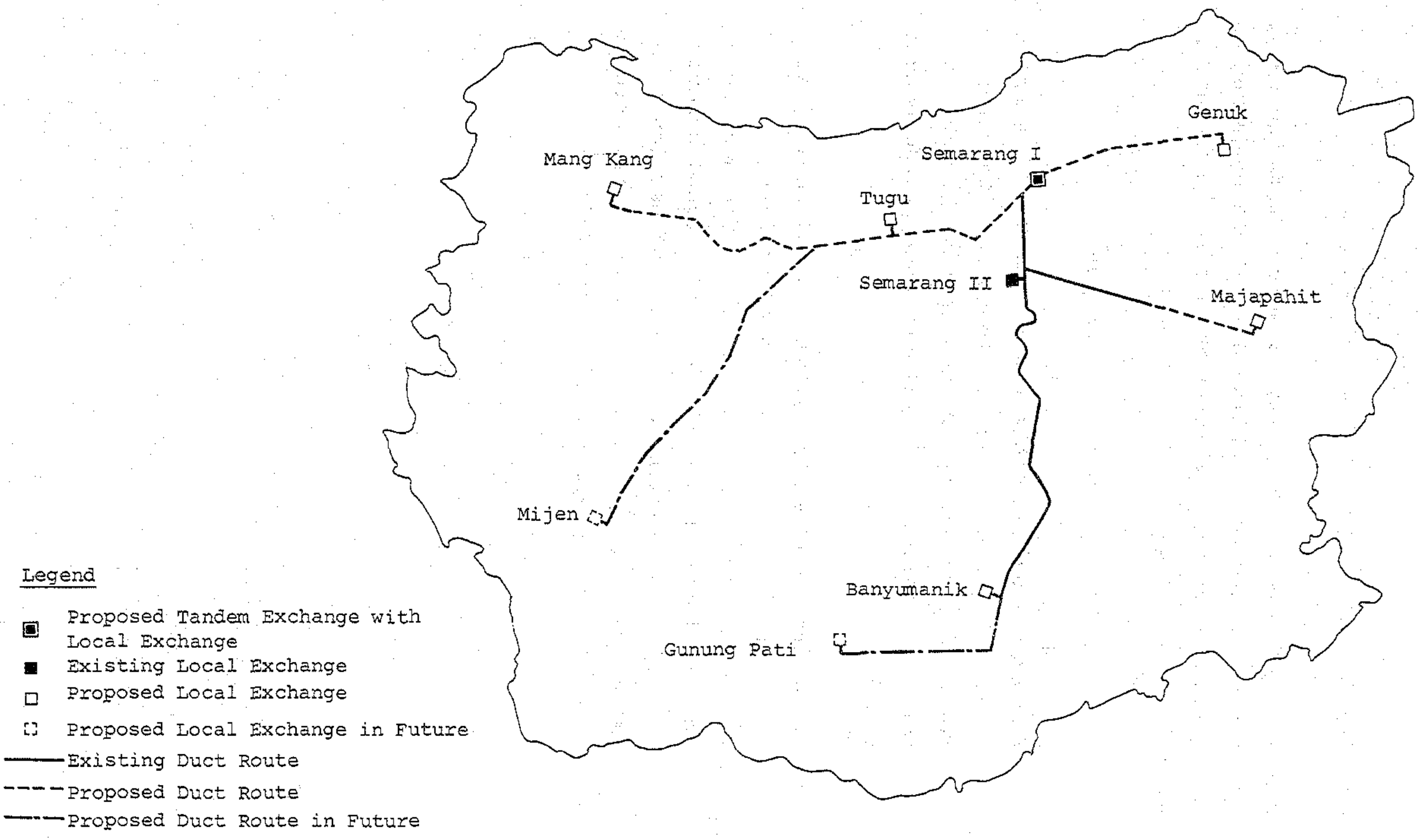


Figure 7-15 Junction Route Map (Semarang)

7-5-3 Solo Area

Existing exchange in Solo City is Solo I Exchange only. This project plans to establish Solo II Exchange and newly install junction cable between Solo I Exchange and Solo II Exchange.

(1) Solo I Exchange - Solo II Exchange

Shortest junction cable route from Solo I Exchange to Solo II Exchange is via Ronggoworsito Street, Yosodipuro Street and Pemuda Seistan Street. At present, this route is without underground conduit facilities.

According to REPELITA III work plan, subscriber cable expansion and underground conduit facilities expansion are carried out on the route mentioned so that there is no need for underground conduit facilities expansion for purpose of new junction cable installation. This junction cable route is schematically presented in Figure 7-16.

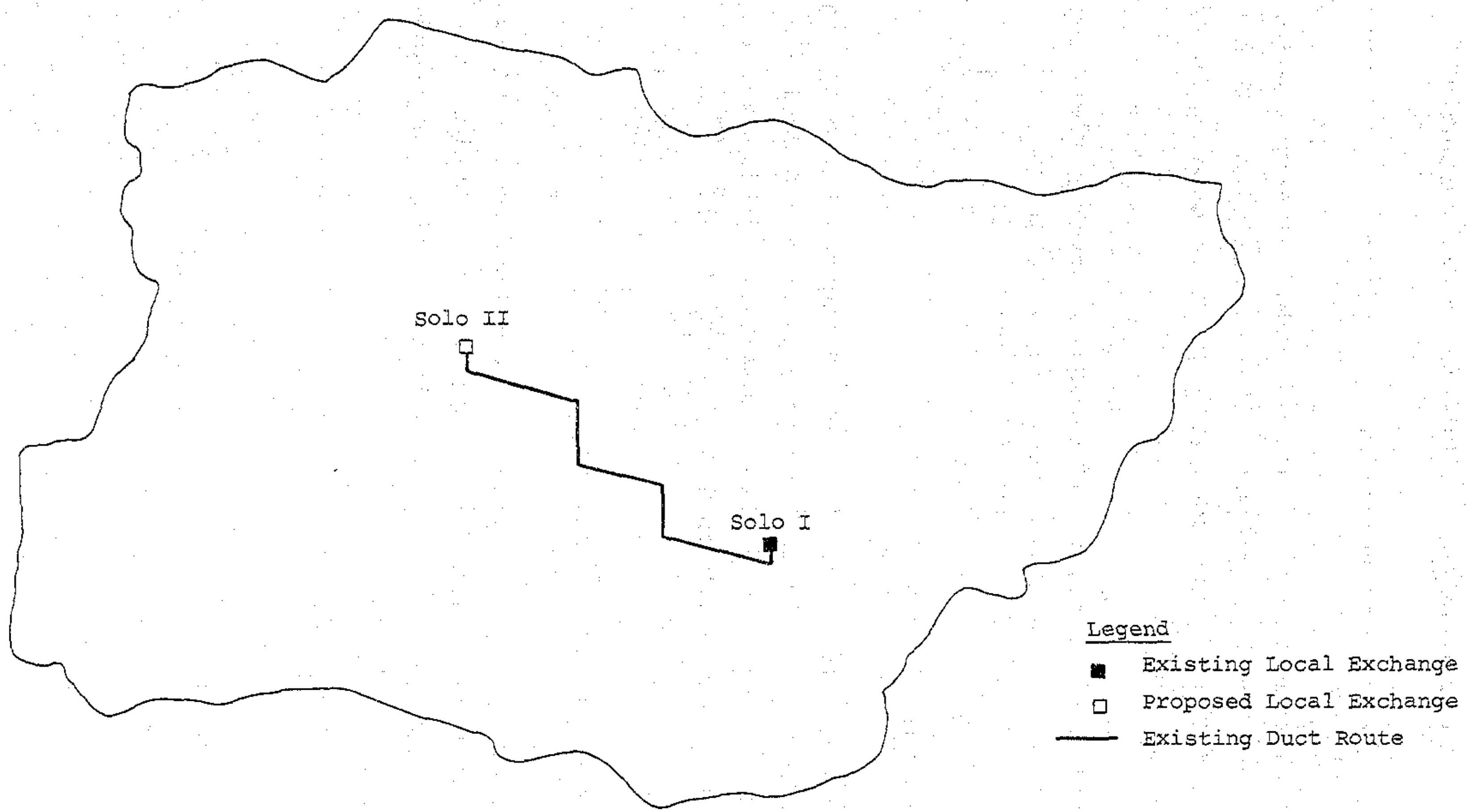


Figure 7-16 Junction Route Map (Solo)

7-6 Estimated Junction Cable System Requirements

7-6-1 Junction Cable Facilities

Major components of junction cable network are junction cables and underground conduit facilities. This time, the latter is included in subscriber cable network components.

Estimated junction cable requirements in three objective cities of this study are in Table 7-3.

7-6-2 Transmission Facilities

Transmission facilities are designed, based on required number of circuits, design standards and design preconditions. Estimated transmission facilities requirements are in Tables 7-4 (1/4) to (4/4).

7-6-3 Power Supply Facilities

Power supply facilities are designed by guidelines described in Chapter 7, Section 7-4. Estimated requirements of power supply facilities for transmission are in Table 7-5.

Table 7-3 Estimated Junction Cable Requirements

Ref. No.	Section		Junction Cable (km)			
	From	To	0.6-200	0.6-100	0.6-80	0.6-40
Medan						
(1)	Centrum I	Centrum II	1.2			
(2)	Centrum I	Suka Ramai	4.0			
(3)	Centrum I	Simpang Limun			4.3	
(4)	Centrum I	Pulau Brayan	4.5			
(5)	Pulau Brayan	Tanjung Mulia		7.9		
(6)	Tanjung Mulia	Labuhan			5.8	
(7)	Labuhan	Belawan				7.0
(8)	Centrum II	Cinta Damai	2.2	4.0		
(9)	Centrum II	Padang Bulan			4.2	
	Sub-Total		11.9	11.9	14.3	7.0
Semarang						
(1)	Semarang I	Semarang II	2.8	2.8		
(2)	Semarang I	Genuk		5.5		
(3)	Semarang I	Tugu	5.9			
(4)	Tugu	Mang Kang			8.0	
(5)	Semarang II	Majapahit		5.9		
(6)	Semarang II	Banyumanik		9.5		
	Sub-Total		8.7	23.7	8.0	
Solo						
(1)	Solo I	Solo II			4.7	
	Total		20.6	35.6	27.0	7.0

Table 7-4 (1/4) Estimated PCM MUX and LTE Requirements (Medan)

Unit: System

	2048 Kbit/s Line Terminal	1ry PCM MUX
Centrum I	247	0
Centrum II	172	74
Suka Ramai (6)	45	2
Pulau Brayan (7)	92	1
Padang Bulan (8)	19	1
Cinta Damai (9)	31	1
Simpang Limun (10)	23	1
Tanjung Mulia (11)	45	1
Belawan (12)	11	0
Labuhan (14)	27	1
Grand Total	710	82

Table 7-4 (2/4) Estimated PCM MUX and LTE Requirements (Semarang)

Unit: System

	2048 Kbit/s Line Terminal	1ry PCM MUX
Centrum I	167	25
Centrum II	157	24
Tugu (6)	77	1
Majapahit (7)	33	1
Banyumanik (8)	36	1
Genuk (9)	24	1
Mang Kang (12)	22	1
Grand Total	516	54

Table 7-4 (3/4) Estimated PCM MUX and LTE Requirements (Solo)

Unit: System

	2048 Kbit/s Line Terminal	1ry PCM MUX
Solo I	26	6
Solo II	26	1
Grand Total	52	7

Table 7-4 (4/4) Estimated Regenerator Requirements

Area	Regenerator Housing (36 SYS)	Regenerator
Medan	34	836 panels
Semarang	27	780 panels
Solo	3	78 panels

Table 7-5 Estimated Power Supply Equipment for Transmission Requirements

Exchange Name	Battery		Rectifier	
Centrum I	24CS	130AH x 2	SID-48V	50A x 2
Centrum II	"	600AH x 2	"	250A x 2
Padang Bulan	"	30AH x 2	"	10A x 2
Cinta Damai	"	30AH x 2	"	15A x 2
Pulau Brayan	"	30AH x 2	"	15A x 2
Tanjung Mulia	"	45AH x 2	"	15A x 2
Labuhan	"	30AH x 2	"	10A x 2
Belawan	"	30AH x 2	"	10A x 2
Suka Ramai	"	45AH x 2	"	15A x 2
Simpang Limun	"	30AH x 2	"	10A x 2
Semarang I	"	290AH x 2	"	100A x 2
Tugu	"	30AH x 2	"	15A x 2
Mang Kang	"	30AH x 2	"	10A x 2
Genuk	"	30AH x 2	"	10A x 2
Semarang II	"	210AH x 2	"	75A x 2
Majapahit	"	30AH x 2	"	10A x 2
Banyumanik	"	30AH x 2	"	10A x 2
Solo I	"	90AH x 2	"	30A x 2
Solo II	"	30AH x 2	"	10A x 2

CHAPTER 8 PROJECT COST ESTIMATION

CHAPTER 8 PROJECT COST ESTIMATION

8-1 Preconditions

Preconditions to project cost estimation are as under.

(1) This project be implemented by implementation schedule given in Chapter 11.

(2) Installation work be executed by turn key base contract awarded to successful bidder in international tender.

(3) Consultant be employed to expedite smooth progress of project implementation including detail design examination, bid evaluation, work supervision and acceptance inspection.

(4) Cost of training for operation and maintenance of the facilities installed by this project be included in project cost.

(5) Rate of exchange to be used in cost calculation be US$1 = Rp.1,100 = ¥250.

(6) Installation cost be calculated for outside plant (subscriber lines, junction lines and civil works), indoor facilities (transmission equipment and power supply equipment), measuring equipment/ vehicles, etc., training, and consulting service, respectively, and for Medan, Semarang and Solo severally.

8-2 Materials and Equipment Procurement

For main materials and equipment to be used in this project, procurement method classification, i.e., by import and by local supply, as decided by prior discussion between PERUMTEL and JICA study team, is as under.

8-2-1 Procurement by Foreign Currency

(1) Outside Plant

1) Splicing materials (including terminating materials), such as splice cases, compounds and connectors

2) Terminal blocks and compounds to be used for distribution points, cross-connecting cabinets, MDFs, etc.

3) MDF frames

4) Gas supply equipment and accessories

5) Steel pipes and accessories

6) Spare parts and manuals

(2) Indoor Facilities

1) 2048 Kbit/s line terminal equipment

2) Primary order PCM multiplex equipment

3) 2048 Kbit/s regenerator equipment (including regenerator housing)

4) Power supply equipment (rectifiers and storage batteries)

5) Spare parts and manuals

(3) Measuring Equipment, Vehicles, etc.

1) Measuring equipment of all kinds

2) Special vehicles for outside plant work

3) Tools

8-2-2 Procurement by Local Currency

(1) Outside Plant

1) Cables and wires

2) Housing for cross-connecting cabinet and distribution points

3) Wooden poles, steel pipe poles and concrete poles

4) Pole accessories for cable laying

5) PVC pipes

6) Manhole and handhole covers (including cover frames)

7) Frames and metals to be used in manholes, handholes and cable vaults

8) Reinforcing bars

9) Cement

10) Temporary work materials (molding material for manhole construction, etc.)

11) Miscellaneous work materials

(2) Indoor Facilities

Main materials and equipment procurement is by foreign currency.

(3) Measuring Equipment, Vehicles, etc.

Same as (2) above.

8-3 Project Cost

8-3-1 Outside Plant

Unit price whereby to calculate outside plant cost is based on standard unit price adopted by PERUMTEL and unit price used in recent international tender for project of the same kind as this project. In outside plant cost estimation, the under-mentioned points are also taken into consideration.

(1) A large number of foreign engineers are expected to participate in work execution.

(2) Work items include such service as basic design and detail design making.

(3) Rehabilitation expense for excavated roads as part of civil works must be paid to responsible party for road maintenance, such as municipal office.

Total cost estimation for outside plant installation, based on amounts of works listed in Chapter 6 and Chapter 7 scopes of works, is as under. For details, refer to Table 8-1.

Objective City	Foreign Currency Portion (¥ million)	Local Currency Portion (Rp. million)
Medan	789	56,269
Semarang	888	64,320
Solo	208	17,608

8-3-2 Indoor Facilities

Total cost estimation for transmission equipment and power supply equipment installation, based on amounts of works listed in Chapter 7 scope of work, is as under. For details, refer to Table 8-1.

Objective City	Foreign Currency Portion (¥ million)	Local Currency Portion (Rp. million)
Medan	328	40
Semarang	241	29
Solo	33	4

8-3-3 Measuring Equipment, Vehicles, etc.

For measuring equipment and tools, as well as vehicles, etc., which are necessary for project implementation and for maintenance work after project completion, cost estimation is as under.

Objective City	Foreign Currency Portion (¥ million)	Local Currency Portion (Rp. million)
Medan	155	0
Semarang	135	0
Solo	73	0

8-3-4 Training, Others

(1) Training

The number of maintenance and installation personnel to receive training for facilities maintenance after project completion and for facilities expansion, as well as expense required for such training, are as under.

1) Training Items, Number of Trainees

Training Item	In Indonesia	Overseas	Total
Subscriber line facilities	40 x 1 month	5 x 1 month	45/month
Subscriber premise facilities	40 x 1 month	5 x 1 month	45/month
Transmission facilities	29 x 2 months	25 x 3 months	133/month
Total	138/month	85/month	223/month

2) Training Expense

Foreign currency portion	¥186 million
Local currency portion	Rp.41 million

(2) Witness to Factory Inspection

Witness to factory inspection is divided into witness in Indonesia and witness overseas, and expense is estimated for each. Witness officer is to be PERUMTEL staff member who performs duty, assisted by Consultant. Expense on Consultant side is to be included in consulting service fee.

Witness to factory inspection expense is as under.

Foreign currency portion	¥6 million
Local currency portion	Rp.8 million

(3) Maintenance Assistance (One year)

After project completion, transmission equipment supplier provides maintenance assistance for one year. This expense is as under.

Foreign currency portion	¥55 million
Local currency portion	Rp.42 million

8-3-5 Consulting Service

Work items to be consigned to Consultant employed for project implementation and expense for consulting service to be provided by Consultant are as under.

(1) Consignment Work Items

1) Check and review of detailed design drawings

2) Check and review of work amount and work cost

3) Check and review of equipments, and materials supplied, as well as construction/installation practices

4) Witness to factory inspection of equipments, and materials to be supplied

5) Supervision of construction work

6) Witness to interim inspection and final acceptance test

(2) Consulting Service Expense

Foreign currency portion	¥632 million
Local currency portion	Rp.1,442 million

8-3-6 Total Project Cost

Total project cost including contingency is as under.

Foreign currency portion	¥4,102 million (US$16,408,000)
Local currency portion	Rp.153,783 million (US$139,803,000)

Breakdown by three objective cities, i.e., Medan, Semarang and Solo, is in Table 8-1.

Table 8-1 Project Cost

(Foreign currency portion in Y million)
(Local currency portion in Rp. million)

Item	Medan		Semarang		Solo	
	Foreign Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency
1. Outside Plant						
1.1 Cable Lines						
(1) Primary Cables	261	11,619	237	11,724	76	3,542
(2) Secondary Cables	514	28,888	638	34,345	131	8,161
(3) Junction Cables	14	494	13	466	1	42
Sub-total	789	41,001	888	46,535	208	11,745
1.2 Civil Works						
(1) Manholes		3,067		3,901		1,184
(2) Conduits		12,201		13,884		4,679
Sub-total		15,268	17,785	5,863		
2. Indoor Facilities						
(1) Transmission Equipment	283	35	208	26	26	3
(2) Power Supply Equipment	45	5	33	3	7	1
Sub-total	328	40	241	29	33	4
3. Measuring Equipment, Vehicles, etc.						
(1) Measuring Equipment, Tools	37		37		23	
(2) Vehicles	118		98		50	
Sub-total	155		135		73	
4. Training, Others						
(1) Training	90	20	70	16	26	5
(2) Factory Inspection	3	3	2	4	1	1
(3) Maintenance Service	30	21	22	18	3	3
Sub-total	123	44	94	38	30	9
5. Total (1 + 2 + 3 + 4)	1,395	56,353	1,358	64,387	344	17,621
6. Consulting Service	271	585	253	577	108	280
7. Total (5 + 6)	1,666	56,938	1,611	64,964	452	17,901
8. Contingency	167	5,694	161	6,496	45	1,790
9. Project Cost	1,833	62,632	1,772	71,460	497	19,691
10. Gross Budget	Foreign currency	4,102(16,408)		Local currency	153,783(139,803)	

Note: Rate of exchange is Rp.1,100 = Y250 = US$1.
Figure in ( ) is given in US dollars (unit: US$1,000).

CHAPTER 9 REVENUE FROM PROJECT

CHAPTER 9 REVENUE ESTIMATION

9-1 Various Considerations Relevant to Revenue Estimation for this Project

9-1-1 This Project and Revenue from Telecommunications System

This project is to formulate a concrete implementation program for improvement and expansion of telephone networks in the three big cities of Medan, Semarang and Solo to be executed by PERUMTEL within the period of REPELITA IV (1984/85 - 1988/89). The objective of the project is specifically the installation of additional subscriber and junction cable networks.

POSTEL has formulated a long term telephone network expansion plan in view of Indonesia's future needs for communication infrastructure. In order to further strengthen this long term plan, this project also aims to develop a long term implementation program for expansion of telephone networks in view of satisfying 100% of the telephone demand in the year 2005 in the aforementioned three big cities.

Accordingly, this project has the following characteristics based on the foregoing planning goal. First, every project components shall be planned to be capable of satisfying the telephone demand forecast for 1993 by the time of completing construction under this project (1989), with the plan to satisfy the telephone demand assumed for the year 2005. Its second characteristic is that some parts of the said project components are designed to satisfy the demand in year 1998 and 2005 and that these design goals are integrated into implementation program.[1/]

At present, the telephone service supply capacities in the aforesaid three big cities are, 36,000 lines in Medan, 19,400 lines in Semarang, and 7,700 lines in Solo, leaving a surplus service capacity of about 9,800 lines in Medan, 4,300 lines in Semarang and 2,000 lines in Solo, respectively. These surplus lines however cannot cope with the demand growth in and after 1987 as forecasted in Chapter 3.

Therefore, the revenue from the whole communication system based on this project can be grasped as follows, in anticipation of additional investment in other system configuration.

(1) The surplus line supply capacity in every city will be completely filled by 1986.[2/] Thus, during the period from the start of the project (1986) until 1993, the revenue over and above the 1986 revenue is the revenue accruing to all of the expanded portion of the communication system in each city including this project and other additional investment.

1/ Refer to Table 9-1.

2/ Since exchanges in subject cities are based on the crossbar system, 2% of the terminal capacity at each exchange is reserved for system operation and maintenance. This reserve becomes unnecessary with the installation of the digital exchanges system.

(2) Major revenue accruing from the portion of the communication system expanded this time with this project after 1994 is the 1993 level revenue of each year after 1994 until 2005 less the 1986 level revenues.

(3) Since the secondary cable under this project is designed to satisfy the demand in 2005, if additional investment in the communication system is to be continued hereafter, a part of revenue from such additional investment ought to belong to this project.

Figure 9-1 illustrates the foregoing.

9-1-2 Revenue Accrued to This Project

The objectives of this project are the junction cable networks and subscriber's line networks in the aforesaid three big cities and do not include other communication system components, namely exchanges, inhouse facilities, toll transmission equipment, etc. Therefore, the revenue accrued to this project is generated only when other facilities are expanded at the same time or when other facilities that already exist can accommodate this project. This is the unique feature of the communications project. In other words, on the premise that additional investment in other system components will be made, the process must be followed in which the revenue of the system as a whole is grasped first and then the revenue accrued to the project concerned is calculated.

There is a certain risk in assuming that additional investment will be made in other communication system components After the year 1994 to 2005 as this project envisages. While if it is assumed that no additional investment is done after 1994, the cost of this project enlarges and that it reduces rate of return of this project. In these instances, the analyses on financial rate of return in the following chapter are carried out by the following two cases. Case No.1 is by assuming all necessary additional investments to be made so that the total telecommunication system will be at work as this project suggests. Case No.2 is no additional investments are made other than the complementary investments for satisfying the demand level of 1993.

Revenue attributable just to this project

Revenue attributable just to this project is calculated through utilization of ratio of this project costs to the assumed total cost of the telecommunication expansion plan in the said three cities. The Chart 9-2 obtained from PERUMTEL illustrates the telecommunication system components ratios to the total system cost.

In addition to these ratios, the CCIT manual suggests 35% for subscriber line investments to the total telecommunication investment costs and 10% for local exchange/exchange line investment cost to the total costs. Based on the above and the characteristics of this project, 35% has been adopted as the percentages of this project costs over the total costs to be incurred to meet the expansion required.

This 35% ratio to be the basis for estimating revenue attributable to this project has been also recognized and agreed with the Indonesian side at the interim report meeting held in Jakarta in March 1985.

Certain elements of the existing system naturally have the service capacity to accommodate new subscribers in and after 1986, but by considering the all past investments which enables such services as a sunk cost, such services would not be deemed as a part of past projects. Accordingly, the same level of revenue up to 1986 shall accrue to the old system in and after 1987, as shown in Figure 9-1. The consequences of this line of reasoning are that the revenue of this project will be overvalued during the 1987-1993 period and undervalued during the 1994-2005 period. The degree of this undervaluation will be extremely larger than the degree of overvaluation when the sunk cost of this project in and after

2005 is taken into account. In turn this way of thought on sunk cost imposes a much severer revenue condition on this project.

From the foregoing, the 1986 level revenue is subtracted from the revenue of the whole system, and the remainder is multiplied by 35% to arrive at the applicable revenue accruable to this project. Earnings accruable to this project between 1994 and 2005 consist of the revenue accruable to this project generated from the 1993 demand level and revenue that belong to the cable line investment in anticipation of the demand in 2005. This incremental portion is calculated on the basis of the ratio obtained by calculating the cost of each line element per subscriber of this project (as of the target year of the project) and multiplying that cost ratio by 35% which is the investment ratio of this project. This ratio (the ratio of accruable earnings) is 11.04% for 1994/1998 and 10.75%[1/] for 1999/2005 since some parts of the project are designed to satisfy 1998 demand. In summary revenue accruable to this project during the project period are shown below.

	Ratio of Accurable Earnings	Earnings Accruable to This Project	
		Case 1	Case 2
1987/93	$A \times 0.35 =$	R_1	B_1
1994/98	$B_1 + (T - B_2) \times 0.1104 =$	R_2	B_2
1999/2005	$B_1 + (T - B_2) \times 0.1075 =$	R_3	B_2

1/ Refer to Figure 9-3.

Here:

A = Gross revenue of the whole system in each year less the gross revenue of the whole system at the 1986 level

B_1 = Earnings accruable to this project at the level of satisfying the demand in 1993

B_2 = Revenue of the whole system at the level of satisfying the demand in 1993

T = Revenue of the whole system in each applicable year

$R_{1,2,3}$ = Earnings accruable to this project in each period assuming additional investment in the whole communication system.

(When there is no other additional investment in the whole system in and after 1994, the earnings of this project would be B_1, B_2, and B_2 in the respective period. Refer to the foregoing Case 2).

9-1-3 Project Period and Residual Values of Each Facility

The project period shall be 20 years from the start-up of construction in 1986 to 2005. This project can generate services from the portion juxtaposed with the existing system within a year after start-up of construction, and in 1987, 30% of the following year target demand shall be satisfied.

The design life of every facility in this project is 20 years or more except batteries in the transmission part (10 years) however, their economic life was assumed to be 20 years. Accordingly, there will be some residual value on the accounting books as left over depreciation at the time of termination of the project period. However, the residual value of the investment in this project is quite small (about 0.1%) when discounted at the prevailing market interest rate and compared to the amount of the initial investment of this project, and hardly affects the financial analysis (internal rate of return) of this project. In this project, therefore, the residual values of various project components shall be assumed to be zero. In the various communication system projects which would probably continue to be undertaken in and after 2005, the residual value of this project would be handled as a sunk cost in the same way as this project has handled past projects. In this respect, too, it seems reasonable to assume the residual values of various facilities of this project as zero.

PERUMTEL assumes the economic life of each subscriber's line facilities as 12 to 15 years, but in view of the existing quality conditions, design standards and the time horizon of this project, the economic life of various facilities in this project was assumed to be 20 years and the residual values, zero.

9-1-4 Revenue Items

Revenues considered in this project are as follows:

Telephone service:	Installation charge	
	Monthly rental fee	
	Call charges - local call	automatic
	- SLDD call	automatic
	- international call	

Non-telephone services: (TELEX)	Installation charge
	Monthly rental fee
	Call charges

Besides the above services, the lines installed under this project can also be utilized for public telephone, private line, data services, etc., but the demand for these and their degree of contribution to revenue, are anticipated to be small by comparison to the afore-mentioned revenues, and therefore, these will not be considered as revenue of this project. In the said three cities, (70% of total revenues are accounted for by the automatic local/SLDD call revenues alone, and the ratio of the telephone service revenues to total revenues ranges between 87% and 90%. Regard to telegraph, none of exchange offices under this project holds a plan to set up a new counter for telegraph services. Thus this project put the revenue from telegraph aside. Currently in those three cities in concern, the revenue arising from telegraph amounts to only about 1% of the total revenue.

The revenue from incoming calls terminating in the three cities concerned are naturally the revenue from call charges for PERUMTEL which is the executing body of this project, but in the financial/economic analysis, revenue of this type will not be included, in order to review the earning capacity of the project in very stringent manner. It is likely that the incremental revenue from incoming calls in the three cities concerned would be associated with the said expansion plan of telephone networks as well as from other projects. Therefore it would be difficult to estimate definitely the portion of in-coming call revenue which accrues just to this project.

According to the data in the three cities concerned, terminating trunk calls are 35 to 50% of originating trunk calls, while out-going SLDD call revenue accounts for 57-60% of the total revenue (in the concerned cities). In view of this pattern, the total revenue of this project will increase by 20-30% if revenue from all in-coming calls are included.

In this respect, the effect on the rate of return when incoming calls are included will be grasped in the sensitivity analysis of revenue variation in the next chapter.

Manual toll calls (toll calls through operator) are not included in the revenue of this project either, in the light of their gradually declining trend and minimul contribution to revenue.1/

1/ At present, the manual toll call revenue in the said three cities accounts for around 2% of the automatic local/toll call revenues.

9-1-5 Communication Service Tariff Structure

Tariff Policies

In general, public rate policies are oriented toward pursuing any one, or some of the following four objectives:

1) Financial goal
2) Increase in government revenue
3) Efficiency in use of resources
4) Equitable measure on economic welfare

PERUMTEL has hammered out a policy adapted to the financial goal 1) above, by which tariff system is designed to generate a reasonable return on investment after meeting the cost of providing services. Also, the tariffs on installation charge, monthly rental fee which differ by area may be claimed as reflecting the viewpoint of maintaining equity measure. PERUMTEL is also contributing to increasing government revenue by the payment of 35% corporate tax and 12% interest on foreign soft loans borrowed by the Indonesian government. According to welfare economics, the market clears when the rate is equal to the marginal cost of generating that service, and as long as the price paid exceeds the cost, the service capacity ought to be expanded. Changes in Indonesia's tariff structure may be perceived as manifestation of its efforts to attain goal 3) above. The installation charge of 500,000 Rp. in 1975 was reduced to 350,000 Rp. in 1980 and further to 200,000 Rp. in 1983 but raised again to 500,000 Rp. in February 1985. This new tariff schedule is intended to cope with the rising costs for operating the communication system and to increase PERUMTEL's own internal financial resources necessary to satisfy the growing telephone demand. Although changes in the tariff schedule is in view in the future due to the above regards, the latest new tariff schedule 1985 is assumed to prevail throughout the life of this project. Although there will not be taken up in this project, it would bring better results to introduce measures to increase average use of lines. At present, calls made during 21:00 P.M. to 6:00 A.M. period are charged half the rate of calls made during 6:00 A.M. to 21:00 P.M. period however, establishment of additional time bands and further discounts would be a possible direction toward improvement on efficient use of the system.

Tariff Structure

The new tariff structure for telephone-based services is as shown on Tables 9-1 and 9-2. The installation charge is set so that it can be appropriated to various expenses incurred in installing telephone, or the basic investment for telephone services, and the call charge to be appropriated to the maintenance and operation expenses.

At present, only in Jakarta local calls are charged by one pulse for every three minutes, while in other areas, one pulse is for every completed call.

SLDD (Subscriber Long Distance Dialing - automatic toll call) differs in pulse-metering time by the distance zone, and is classified into six different categories from the intra-city (calls within the same exchange number but between different exchanges) of one pulse per every minute, to the 1,000 km distance zone of one pulse per every two seconds. There is also the inter-local manual charge, for which the tariff schedule is 50% of the SLDD service for normal calls and the same as SLDD for urgent calls. The calls are charged by the Three Minutes-One Minute System (by the unit of minimum three minutes and per every one minute thereafter).

The foregoing automatic telephone services are charged by the number of pulses, and the new tariff schedule has raised the charge per pulse from 60 Rp to 75 Rp and improved the call charge earning power by 1.25 times than that of the old schedule. Differentiation of charges by the purpose of telephone use is not practiced in Indonesia. The tariff schedule for the telex is the same in installation charge as for the telephone, but the monthly rental is uniformly set at 75,000 Rp. The traffic charge is the same as for the telephone at 75 Rp per pulse, but the distance zoning and the pulse intervals by zone are different from the rate schedule from the automatic telephone services as seen below.

Telex Traffic Charging System

Zone	Distance (km)	Pulse interval (second)	Pulses per minute
I	Withing 50 km	12	5
II	50 to 300	8	7.5
III	300 to 500	6	10
IV	over 750	3	20

9-2 Revenue Estimation

Estimated revenue by item accruing to this project are stated in Tables 9-3 through 9-5. The method of calculation employed is as follows. Firstly the number of new subscribers and the total accumulated number of subscribers in each year during the project period are obtained from the forecast demands in Chapter 3 and the emand capturing plan as mentioned in Chapter 4, and then applying the tariff schedule described in the preceding paragraph, the revenue by each item for the total system, is calculated. After substracting the 1986 level revenue of the total system therefrom, the remainder is multiplied by the ratio of revenue accruable to this project as was discussed in the preceding section.

Revenues from Installation Charges/Monthly Rental Charges

Both revenues were estimated on the basis of projected demand to be satisfied and the applicable tariff schedule for each of the three cities according to the foregoing procedure. What should be noted in Tables 9-3 through 9-5 is that with respect to the monthly rental charges, the revenue accruable to this project at the 1993 demand level continues from 1994 to 2005, and also that the revenue which ought to accrue to the investment designed to meet the year 2005 demand is added to the above. The revenue from installation charges is the revenue for the year of subscription only, so that after 1994, the revenue from installation charges accrued to this project is proportional to the investment cost ratio given in the previous section.

Telephone Call Charges

In the interim report, revenue from telephone call charges was estimated on a trial basis based on the systematic correlations among the total number of subscriber circuits, busy hour traffic and the automatic local/SLDD call charge revenue per subscriber circuit, applying the projected number of subscribers and projected busy hour traffic.[1/] This time, the revenues from local calls, toll calls and international calls are calculated individually and then added up to arrive at a detailed revenue estimation for this project. The calculated results was almost identical with that of the interim report. The calculation formula applied to local/toll calls is as follows:

$$AR = (BT/BCR)/MT \times CR \times PC \times WD \times 75\ Rp \times Sub$$

where AR = annual call charge revenue

BT = busy hour traffic

BCR = busy hour concentration ratio (1/8)[2/]

MT = average holding time of complete call/incomplete call (1.5 minutes)

CR = completion ratio (0.5)

PC = number of pulses per complete call[3/]

WD = annual working days

1/ Total call charge revenue per subscriber circuit in year t = Total call charge revenue per subscriber circuit in base year x Busy hour traffic in year t/Busy hour traffic in base year

2/ Figures in parentheses are the coefficients used in forecasting traffic in this project.

3/ Refer to Table 9-6.

75 Rp = charge per pulse

Sub = total number of subscriber circuits

What the above formula means is to multiply the number of complete calls and incomplete calls per subscriber circuit per day by the complete ratio to obtain the number of complete calls per circuit per day, then multiply it by the number of pulses per complete call to obtain the total number of pulses per circuit per day, then further multiply it by the charge per pulse, total number of subscriber circuits and annual working days to obtain the total annual revenue from call charges. As for the number of pulses per complete call, one pulse per every three minutes is used for local call. For SLDD 16.17 pulse per one minute complete call for Medan, for Semarang 17.57 and for Solo 12.9 are applied based on the call pattern analysis for each city. To the total call charge revenue obtained as above, the method of calculating the accruable revenue described previously in section 9-1-2 was applied to obtain the revenue accruing to this project. As stated in section 9-1-4, the revenue from in-coming calls is not included, but the impact of including such revenue can be easily grasped estimated by the sensitivity analysis in the next chapter.

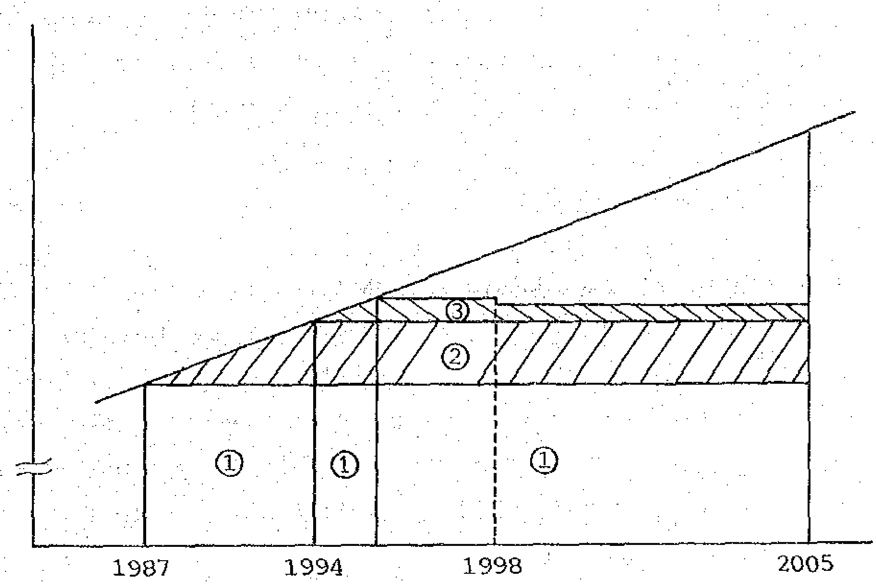
Revenue from International Calls

As for international calls, which are anticipated to grow sharply from now on, the number of charged minutes for complete international calls are forecasted by this survey mission with due regard to the demand forecast made by INDSAT. Then these charged minutes are mutiplied by the flat current international call charge of 2,982 Rp per minutes.[1/] Based on the prevalent pattern of international calls, and the revenue accruing to this project is calculated by the preceeded procedure. Starting this year, PERUMTEL's revenue from the originating international calls is set at 25% of the total revenue from international calls.

Revenue from telex

The revenue from telex is calculated based on the installation charge and domestic originating traffic rates stated in Chapter 4 with the same procedure as above. The traffic revenue comprises of the domestic originating traffic revenue only. The in-coming traffic charges are not included in the same manner as the telephone traffic.

1/ Refer to Table 9-6. The international call charges were calculated by the weighted average based on the call pattern.



① Revenue accrued to the current system

② Revenue accrued to the project aiming to capture the demand level of 1993

③ Revenue accrued to the project aiming to capture the demand level of 2005

Figure 9-1 Project Revenue and the Total System Revenue

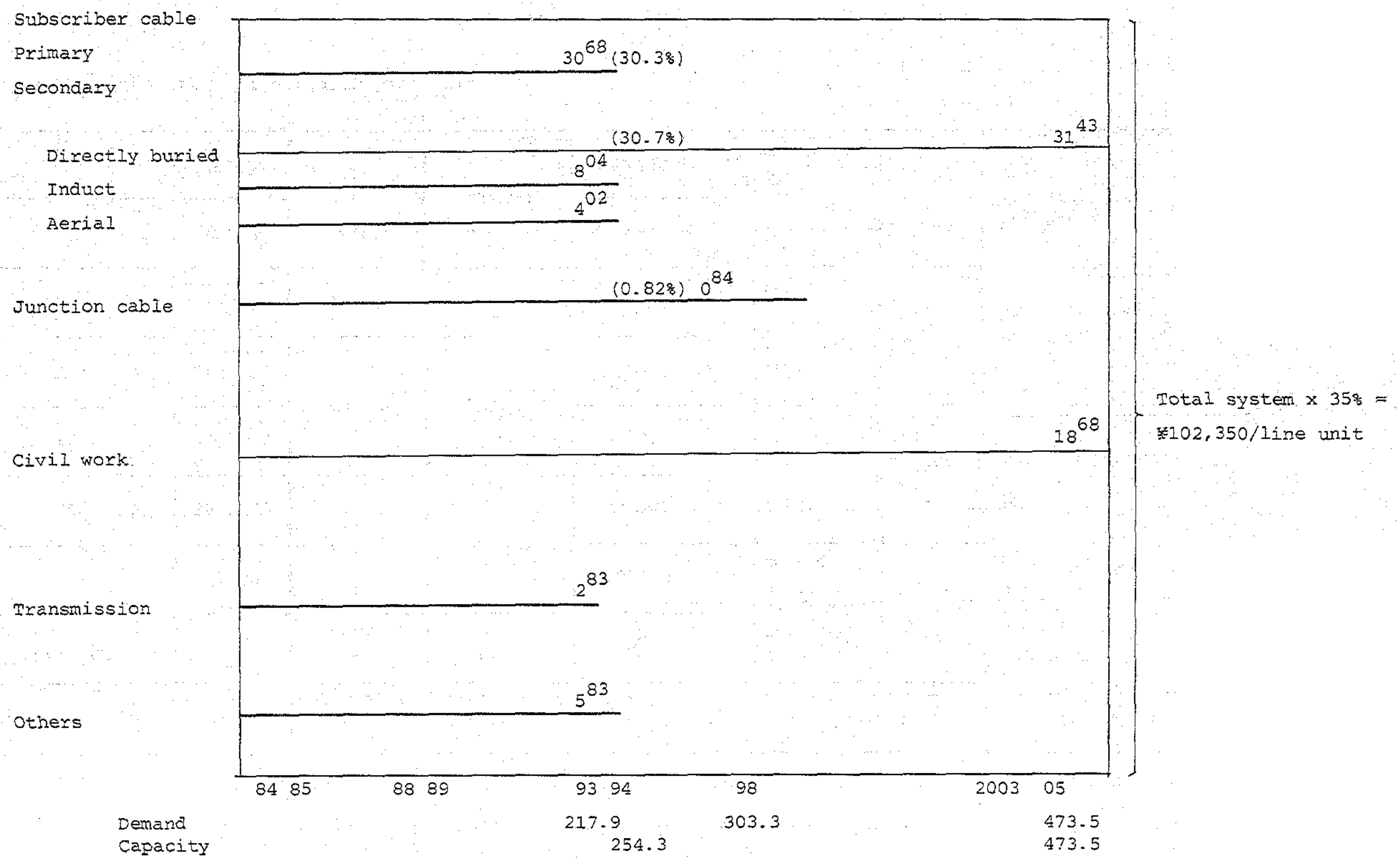


Figure 9-2 Degree of Capturization/Cost per Capturization

Feb. 19, 1985

Table 9-1 Telephone Tariff in Indonesia

Installation Fee		Extra Additional Fee Outside the service area		Brunch Tel. Inst. Fee	Rental Fee/Month Rp.			Local Call Fee Rp.	SLDD & INTERLOCAL
Classification of Area	Rp.	Rp. (Route)	Rp. (Route)	Rp.					
I	500,000	50,000	100,000	60,000	AUTO	JAKARTA BANDUNG SEMARANG SURABAYA MAEDAN	3,500 BL 1) 1,750	JAKARTA Subscribers & P.C.O. Rp. 75: JAKARTA	See the Next Table
II	350,000			30,000		Other	2,000 BL 1,000	Rp. 50: Public telephone pulse = 3 minutes	
III	200,000	40,000	80,000	20,000					
IV	175,000			15,000	MANUAL	Below 500 Units Exchange	1,000 BL 500	Others Rp. 75/call with no time limit	
V	125,000	30,000	60,000	10,000					
VI	90,000	20,000	40,000	7,500		Over 500 Units Exchange	2,000 BL 1,000	Interlocal Rp. 75/pulse pulse = 60 second	
VII	75,000			3,750					

Notes: 1) BL stands for a Branch Line Unit

Table 9-2 SLDD and INTERLOCAL (Manual Trunk Call) Fee

Feb. 19, 1985

ZONE	Distance (km)	Mannual Trunk Call Fee for one minute (Rp.)		SLDD (Rp. 75/1 Pulse))			
				Metering Pulse Interval (Sec)		Fee for one munute (Rp.)	
				Day	Night	Day	Night
		Nomal	Urgent	0.600 - 21.00	21.00 - 0.600	0.600 - 21.00	21.00 - 0.600
O	0 - 25 Intralocal	75	75	60(1) 3)	60	75	75
I	25 - 100	375	750	6(10)	12	750	375
II	100 - 200	450	900	5(12)	10	900	450
III	200 - 300	563	900	4(15)	8	1,125	563
IV	300 - 1,000	750	1,500	3(20)	6	1,500	750
V	Over 1,000	1,125	1,500	2(30)	4	2,250	1,125

Note:

1) The Mannual Call is changed in the form of first 3 minutes minimum plus additional charge per a minute. The Call Tariff is half of that of SLDD.

2) The Mannual Call is devided into ordinary and urgent call with no provision on day/nigth and charge for urgent call is same as the day-time charge of SLDD.

3) ( ) shows Number of pulse per one minutes.

Table 9-3 Revenue Projection for MEDAN

MEDAN

Revenue Accrued to the Project	1986	1987	1988	1989	1990	1991	1992	1993
Annual Installation Revenue	0.0	1440.6	3378.6	0.0	0.0	2535.8	0.0	0.0
Annual Monthly Charge	0.0	172.9	578.3	578.3	578.3	882.6	882.6	882.6
ANNUAL TRAFFIC Revenue	0.0	3693.4	12310.1	12392.2	12474.8	18864.8	18971.3	19078.3
INTERNATIONAL CALLS Revenue	0.0	44.0	65.6	90.4	118.9	151.8	189.5	233.0
TELEX. REV.	0.0	316.3	522.6	673.5	866.1	1081.7	1323.1	1593.6
INSTALLATION FEE	0.0	16.2	37.8	18.9	21.2	23.7	26.6	29.8
MONTHLY CHARGE	0.0	8.6	13.9	18.8	24.2	30.3	37.1	44.8
TRAFFIC REV.	0.0	291.5	470.9	635.9	820.7	1027.6	1259.4	1519.0
TOTAL TLX	0.0	316.3	522.6	673.5	866.1	1081.7	1323.1	1593.6
TOTAL	0.0	5667.2	16855.1	13734.5	14038.1	23516.6	21366.6	21787.5

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Annual Installation Revenue	857.8	289.8	54.1	711.0	428.9	316.1	549.3	462.8	500.4	530.5	643.4	699.8
Annual Monthly Charge	1138.5	1173.3	1179.8	1265.1	1316.5	1348.9	1414.9	1470.4	1530.4	1594.1	1671.3	1755.3
ANNUAL TRAFFIC Revenue	24530.2	25296.9	25472.5	27315.8	28453.0	29124.3	30508.3	31670.5	32926.4	34256.8	35871.4	37626.5
INTERNATIONAL CALLS Revenue	240.1	248.0	250.8	269.6	282.4	292.4	309.2	325.5	343.8	364.1	387.9	414.3
TELEX. REV.	1642.5	1720.4	1805.3	1897.9	1998.8	2055.1	2130.6	2210.5	2295.3	2385.2	2480.4	2581.4
INSTALLATION FEE	7.9	8.6	9.4	10.2	11.1	7.9	8.4	8.9	9.4	9.9	10.5	11.2
MONTHLY CHARGE	46.8	49.0	51.4	54.1	56.9	58.6	60.8	63.1	65.5	68.0	70.8	73.6
TRAFFIC REV.	1587.8	1662.8	1744.5	1833.6	1930.7	1988.6	2061.4	2138.6	2220.5	2307.2	2399.1	2496.6
TOTAL TLX	1642.5	1720.4	1805.3	1897.9	1998.8	2055.1	2130.6	2210.5	2295.3	2385.2	2480.4	2581.4
TOTAL	28409.1	28728.4	28762.4	31459.3	32479.5	33136.8	34912.3	36139.7	37596.4	39130.7	41054.4	43077.3

Table 9-4 Revenue Projection for SEMARANG

SEMARANG

Revenue to the Project	1986	1987	1988	1989	1990	1991	1992	1993
Annual Installation Revenue	0.0	669.2	1626.8	0.0	0.0	1071.0	77.0	0.0
Annual Monthly Charge	0.0	140.5	487.8	487.8	487.8	712.7	728.9	728.9
Annual Traffic Revenue	0.0	4344.8	15368.4	15508.9	15650.3	23177.7	23896.7	24085.9
International Calls Revenue	0.0	19.8	29.5	40.7	53.6	68.4	85.4	105.0
TELEX REV.	0.0							
INSTALLATION FEE	0.0	3.1	7.3	3.7	4.1	4.6	5.2	5.8
MONTHLY CHARGE	0.0	2.9	4.7	6.4	8.2	10.3	12.6	15.2
TRAFFIC REV.	0.0	161.0	260.1	351.2	453.2	567.5	695.5	838.9
TOTAL TLX	0.0	167.1	272.1	361.2	465.6	582.4	713.3	859.9
TOTAL	0.0	5154.5	17483.0	15996.7	16138.1	24961.4	24702.6	24814.8

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	344.4	156.8	53.0	183.3	139.1	154.8	165.6	176.3	187.1	202.1	169.9	180.6
	891.8	924.7	935.8	974.3	1003.5	1032.3	1067.1	1104.1	1143.4	1185.8	1221.5	1259.4
	29487.8	30578.0	30944.4	32218.4	33184.3	34137.1	35288.2	36514.0	37814.4	39219.3	40399.3	41654.0
	118.9	123.4	125.6	131.4	136.4	141.6	148.0	155.2	163.3	172.3	181.4	191.7
	1.5	1.7	1.8	2.0	2.2	1.5	1.6	1.7	1.8	1.9	2.0	2.2
	15.9	16.7	17.5	18.4	19.3	19.9	20.7	21.4	22.2	23.1	24.0	25.0
	876.9	918.3	963.5	1012.7	1066.3	1098.3	1138.5	1181.1	1226.3	1274.2	1325.0	1378.8
	894.4	936.7	982.8	1033.0	1087.8	1119.7	1160.7	1204.3	1250.4	1299.2	1351.1	1406.0
	30724.0	31659.4	31933.2	33376.0	34327.0	35324.2	36520.9	37794.4	39144.8	40607.2	41790.7	43094.0

Table 9-5 Revenue Projection for SOLO

SOLO

	1985	1986	1987	1988	1989	1990	1991	1992	1993
Revenue Accrued to the Project									
Annual Installation Revenue		0.0	220.5	514.5	0.0	0.0	361.4	30.6	0.0
Annual Monthly Charge		0.0	30.2	102.0	102.0	102.0	151.5	155.7	155.7
Annual Traffic Revenue		0.0	1112.4	3932.7	3968.3	4004.2	5982.2	6195.0	6243.7
International Calls Revenue		0.0	4.9	7.2	10.0	13.1	16.7	20.9	25.7
TELEX REV.		0.0	2.8	4.9	5.7	7.2	8.9	10.9	13.1
INSTALLATION FEE		0.0	0.5	1.2	0.6	0.6	0.7	0.8	0.9
MONTHLY CHARGE		0.0	0.5	0.8	1.1	1.5	1.9	2.3	2.7
TRAFFIC REV.		0.0	1.8	2.9	3.9	5.1	6.4	7.8	9.4
TOTAL TLX		0.0	2.8	4.9	5.7	7.2	8.9	10.9	13.1
TOTAL		0.0	1370.8	4561.3	4085.9	4126.5	6520.8	6413.2	6438.2

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Annual Installation Revenue	189.9	34.8	15.5	56.0	38.6	35.7	37.6	39.5	39.5	47.0	33.9	35.7
Annual Monthly Charge	186.5	191.3	193.4	201.1	206.4	210.7	215.8	221.3	226.7	233.1	237.8	242.7
Annual Traffic Revenue	7460.6	7648.2	7730.8	8033.4	8241.5	8408.3	8610.6	8823.0	9035.2	9288.0	9469.3	9660.7
International Calls Revenue	28.9	29.7	30.2	31.6	32.7	33.8	35.1	36.5	38.1	40.1	41.9	50.5
TELEX REV.	25.2	39.2	54.5	71.1	89.3	16.1	16.7	17.4	18.0	18.8	19.5	20.3
INSTALLATION FEE	0.2	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3
MONTHLY CHARGE	15.1	28.7	43.4	59.5	77.0	3.6	3.7	3.9	4.0	4.2	4.3	4.5
TRAFFIC REV.	9.8	10.3	10.8	11.4	12.0	12.3	12.8	13.2	13.8	14.3	14.9	15.5
TOTAL TLX	25.2	39.2	54.5	71.1	89.3	16.1	16.7	17.4	18.0	18.8	19.5	20.3
TOTAL	7891.2	7943.3	8024.4	8393.3	8608.6	8704.6	8915.9	9137.7	9357.6	9627.0	9802.4	10009.9

Table 9-6 Call Patterns and Average Pulse/Charge

Out-Going Call Pattern

	MEDAN	SEMARANG	SOLO
ZONE-0	20.25	35.26	33.71
ZONE-1	20.12	14.70	37.02
ZONE-2	25.34	5.17	8.31
ZONE-3	9.91	0.98	7.80
ZONE-4	9.56	40.29	12.66
ZONE-5	14.82	3.60	0.51
	100.0	100.0	100.0
Average Pulse per One Minute	16.17	17.57	12.9

International Call Pattern

SINGAPORE	33.0
USA	19.3
JAPAN	11.1
HONGKONG	7.7
OTHERS	28.9
	100.0
	2982.0

Average charge per one minute

CHAPTER 10 PROJECT EVALUATION

CHAPTER 10 PROJECT EVALUATION

10-1 PERUMTEL's Financial Position

10-1-1 Operational Position

The profit and loss statements of PERUMTEL's last five years are summarized as below.

Table 10-1 Summary of Profit and Loss Statement

(10^9 Rp)

	1980	1981	1982	1983	1984 1)
Operating revenues	189.89	245.90	323.92	408.44	483.08
Operating expenses	129.98	199.36	263.70	336.51	372.43
Operating profit	59.91	46.54	60.22	71.93	110.65
Return on investment (%) 2)	2.3	1.9	2.4	2.5	3.4
Return on investment (%) 3)	6.42	5.83	7.6	7.54	11.0

(Rp)

	1980	1981	1982	1983	1984 1)
Profit/subscriber line	161,987.65	108,945.77	126,656.56	142,930.10	172,890.63
Revenue/subscriber line	513,434.08	575,628.83	681,278.51	811,599.73	754,812.50
Expenses/subscriber line	351,446.42	466,683.05	554,621.95	668,669.64	581,921.88

Note: 1) PERUMTEL's unofficial internal figures, to be approved.

2) Return on equity

3) Return on networth

During the past five years, PERUMTEL's return on investment remained at a low level except 1984. This is due to the declining profit per subscriber line unit caused by rising cost per subscriber line unit and increased investment during the said period. Facing with this low rate of return and low level of profit per subscriber line unit, PERUMTEL has raised tariff schedule in February 1985. Prior to this tariff raise, PERUMTEL has been imposed less corporate tax of 35% from previous 45% with provision on installation revenue where only 5% of total installation revenue is subject to the revenue at each year with 20 years period of write off and the remainder in each year is retained as PERUMTEL's internal fund source. With these measures PERUMTEL's operational position is expected to be improved.

While the return on investment remained low, the revenue and expense per subscriber showed parallel movement. This parallel movement was the result of pulse charge raise in 1982 and in 1983. It would be difficult to foresee that this way of keeping operational position decently could be adopted continuously. The fundamental measures for operational improvement is in view. New projects for more sales or cost reduction measures should be in focus.

The ratio of profit on sales has declined from 10.7% in 1980 to 7.0% in 1983. This implies the increase in operating expenses per subscriber line. Therefore the efforts for effective expense control seems necessary. One of such measures such as early recovery of accounts receivable would contribute to this significantly.