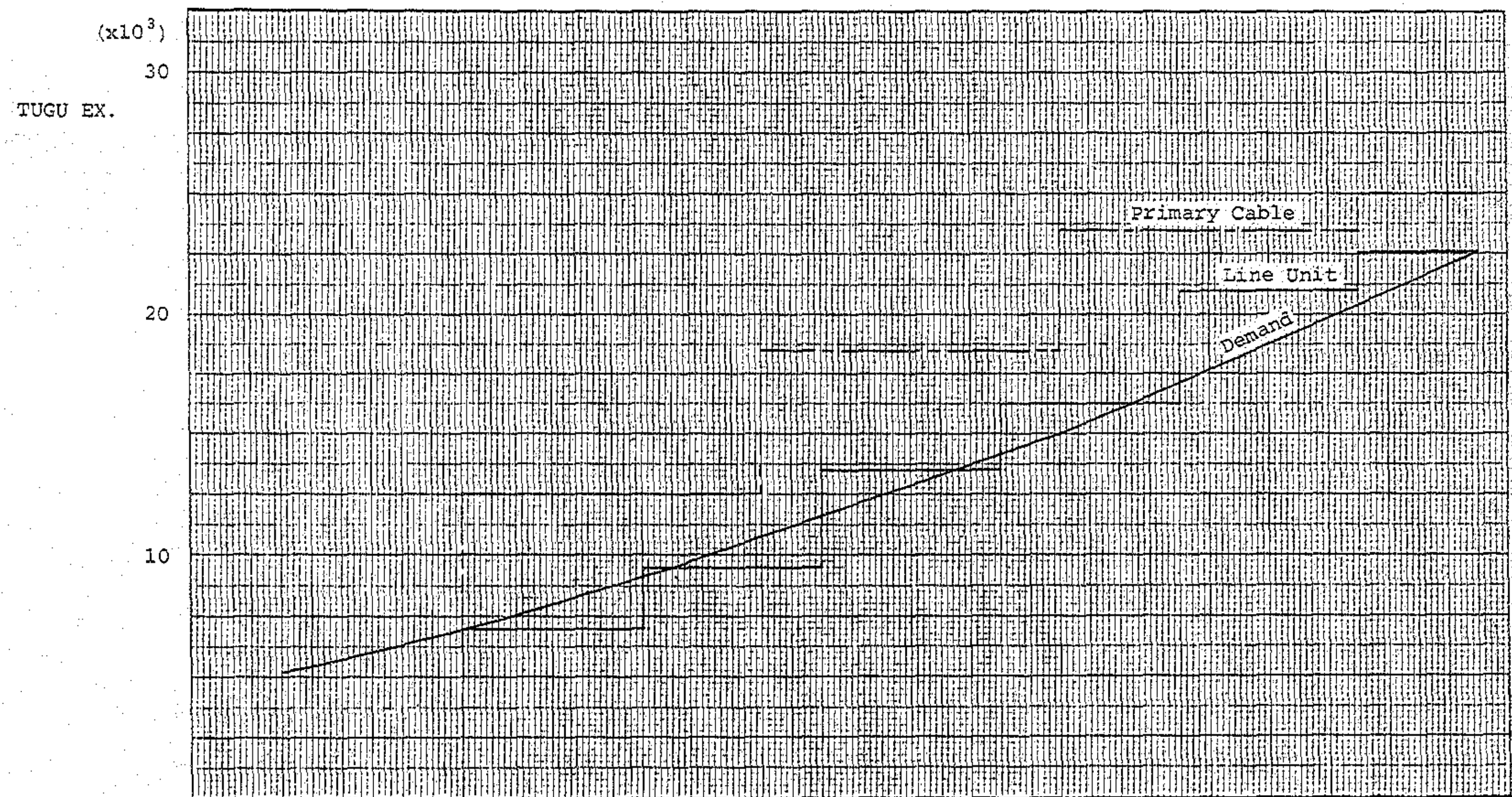
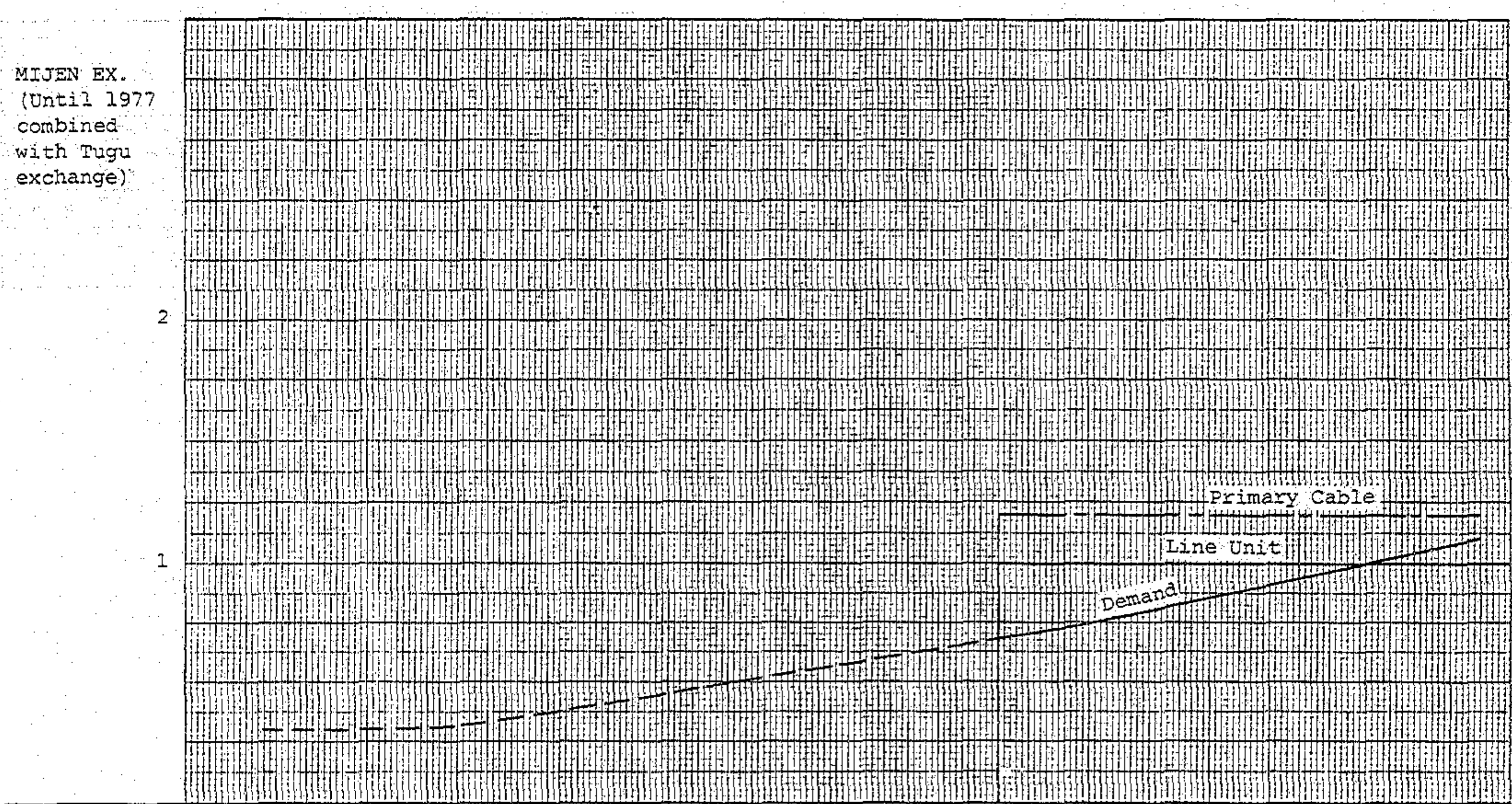


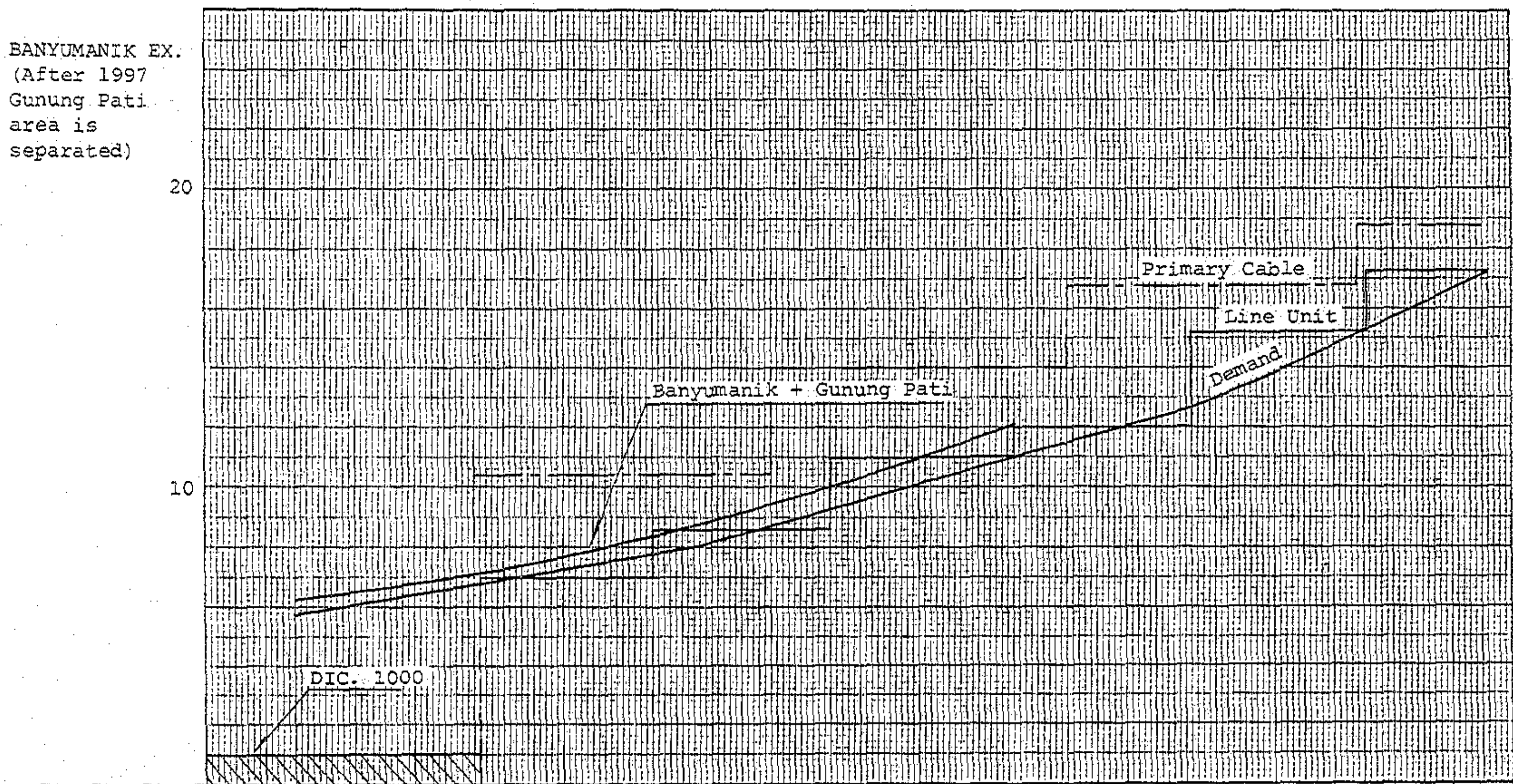
Year	1984	85	86	87	88	89	1990	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	2005
Demand		5.22			7.0		8.3			10.6		12.5			15.0		17.1			21.3		22.7
Line Unit					7.0			9.5			13.5			16.2			21.1			22.7		-
Primary Cable					12.6					18.4					23.4					25.0		
Remark																						

Figure AN-3-16 Installation Target of Tugu Exchange



Year	1984	85	86	87	88	89	1990	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	2005
Demand		(0.3)			(0.3)		(0.4)			(0.5)		(0.6)			(0.7)		0.8			1.0		1.1
Line Unit														0.8			1.0			1.1		-
Primary Cable														1.2						1.2		
Remark																						

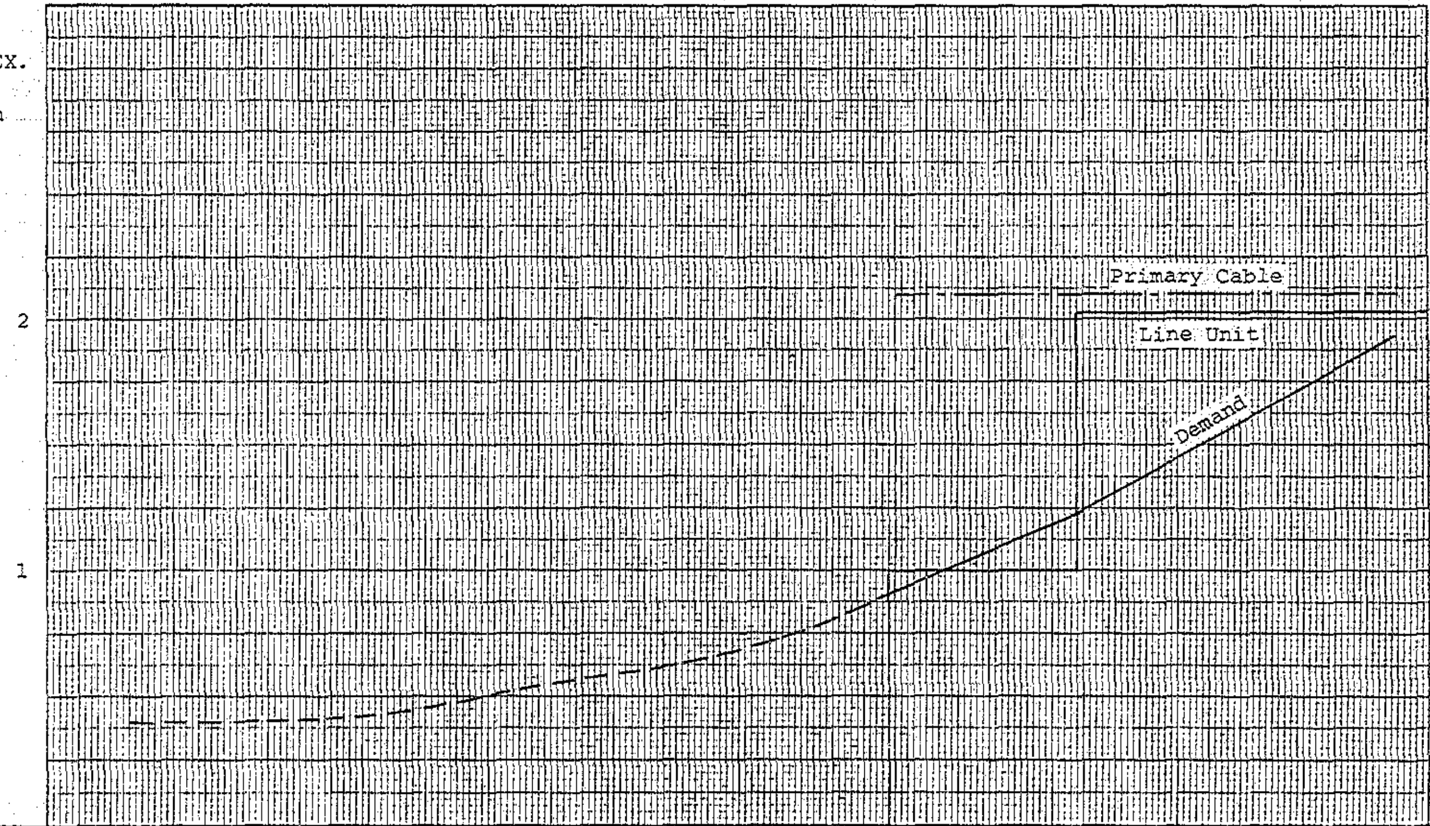
Figure AN-3-17 Installation Target of Mijen Exchange



Year	1984	85	86	87	88	89	1990	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	2005
Demand		5.7			6.7		7.4			8.6		9.9			11.4		21.8			15.2		17.1
Line Unit					6.8			8.6			10.9			12.3			15.2			17.1		-
Primary Cable					10.4					14.0					16.7					18.8		
Remark		(0.4)			(0.4)		(0.5)			(0.6)		(0.7)										
		Figures above are Demand of "Gunung Pati"																				

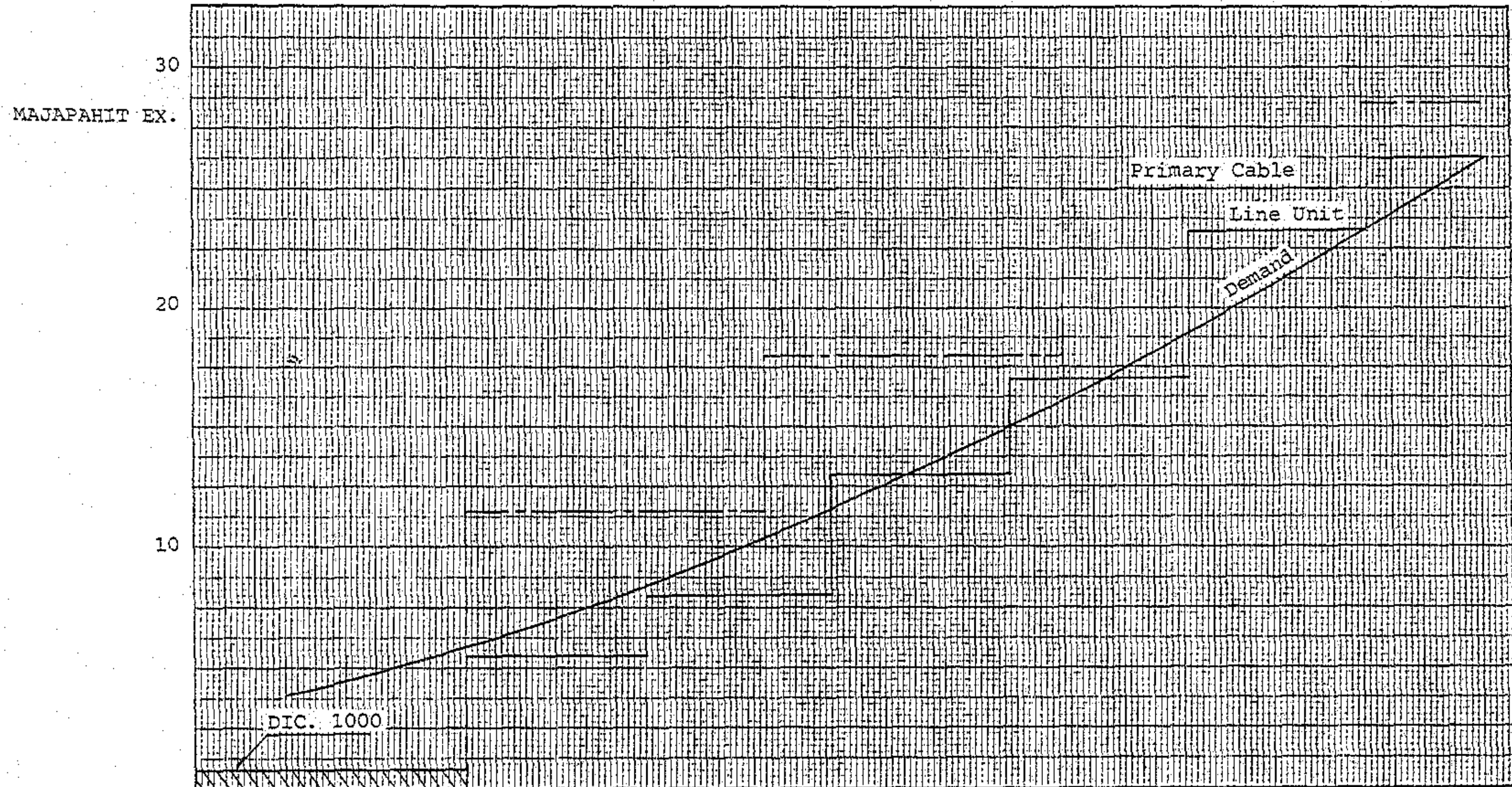
Figure AN-3-18 Installation Target of Banyumanik Exchange

GUNUNG PATI EX.
(Until 1977
combined with
Banyumanik)



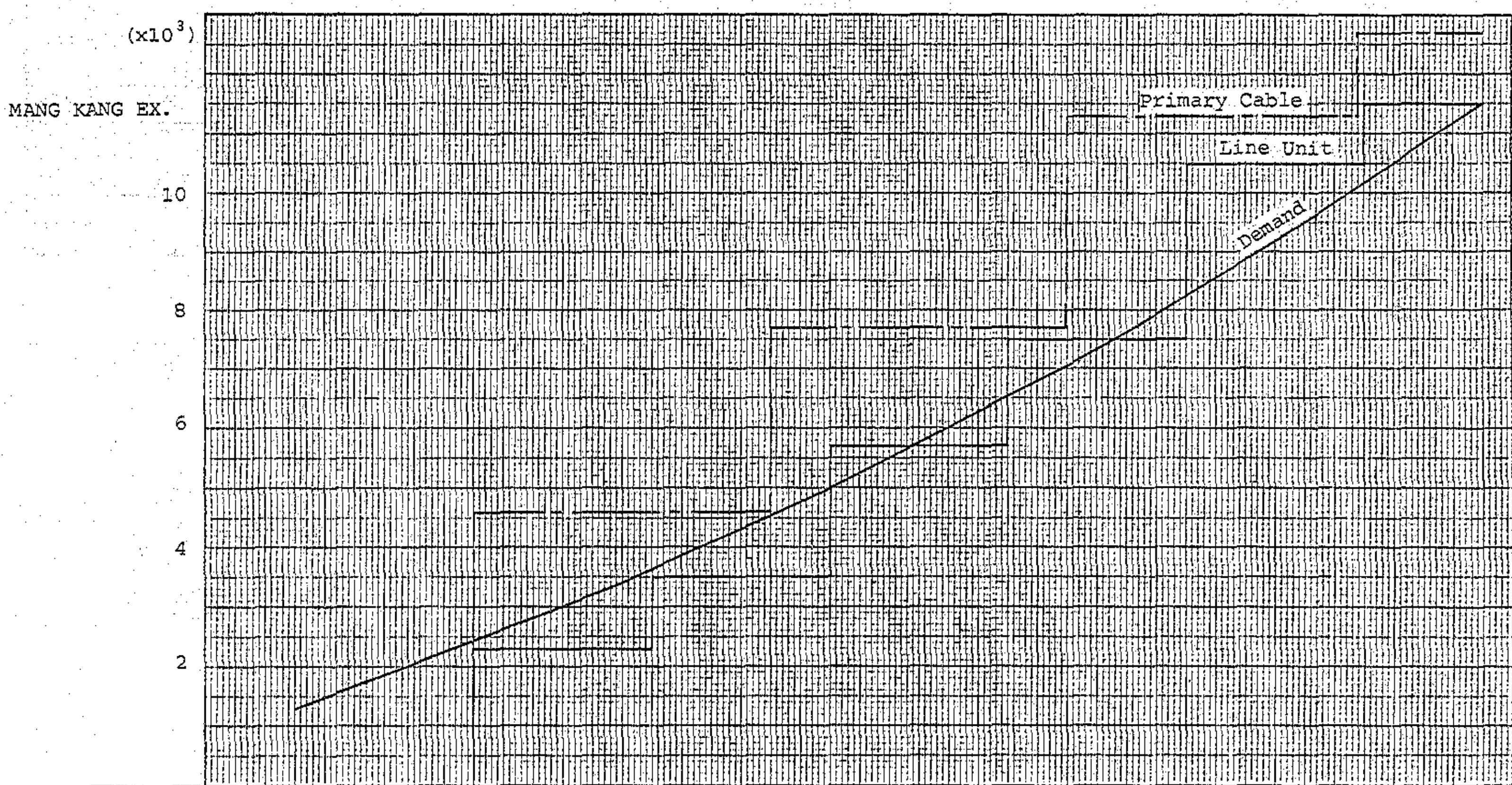
Year	1984	85	86	87	88	89	1990	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	2005
Demand		(0.4)			(0.4)		(0.5)			(0.6)		(0.7)			1.0		1.2			1.7		1.9
Line Unit														1.0			1.7			1.9		-
Primary Cable															2.1					2.1		
Remark																						

Figure AN-3-19 Installation Target of Gunung Pati Exchange



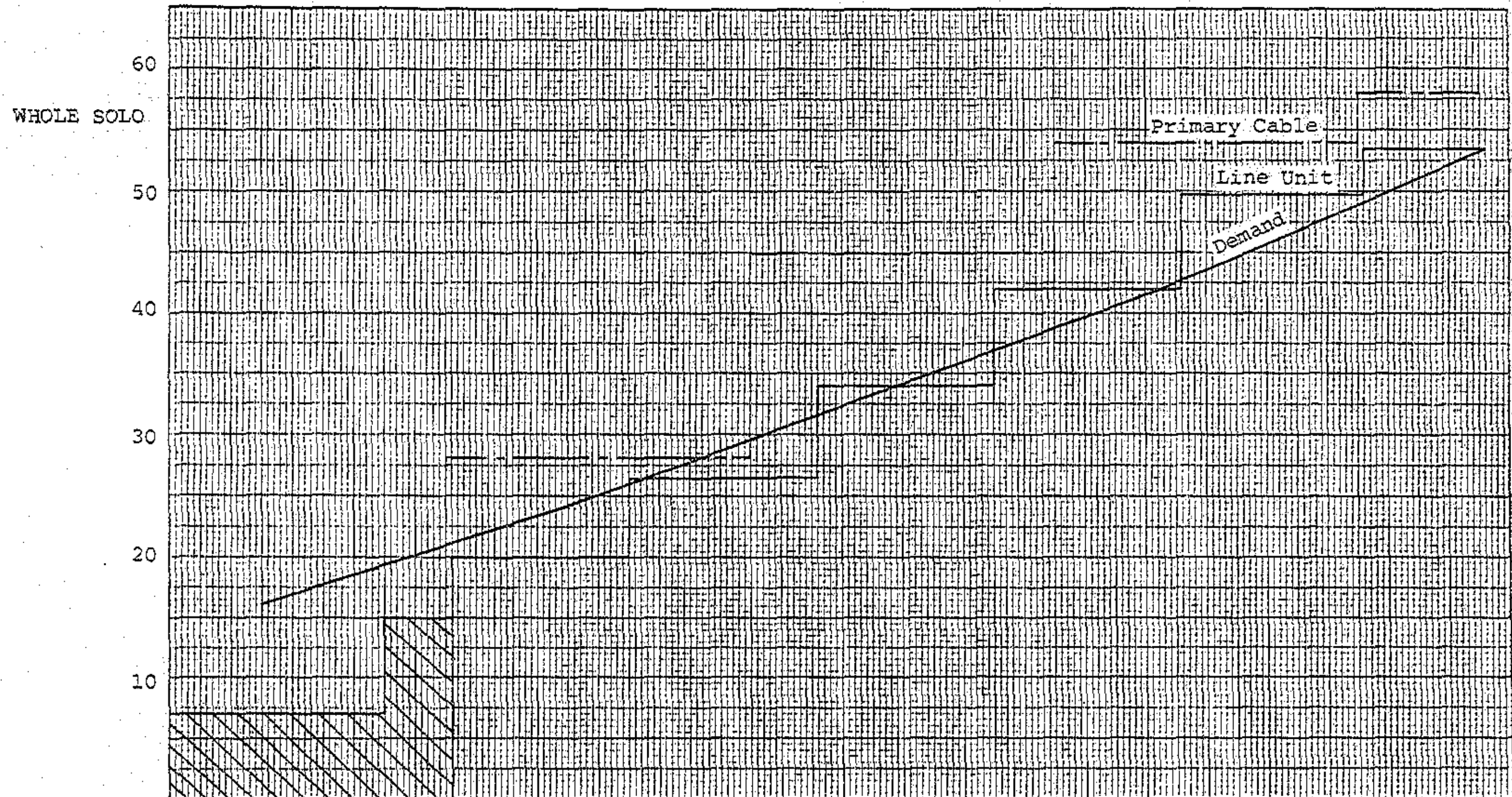
Year	1984	85	86	87	88	89	1990	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	2005
Demand		3.7			5.7		7.2			9.9		12.4			15.6		18.3			22.8		25.9
Line Unit					5.4			7.8			12.7			16.8			22.8			25.9		-
Primary Cable					11.4					18.0					25.1					28.5		
Remark																						

Figure AN-3-20 Installation Target of Majapahit Exchange



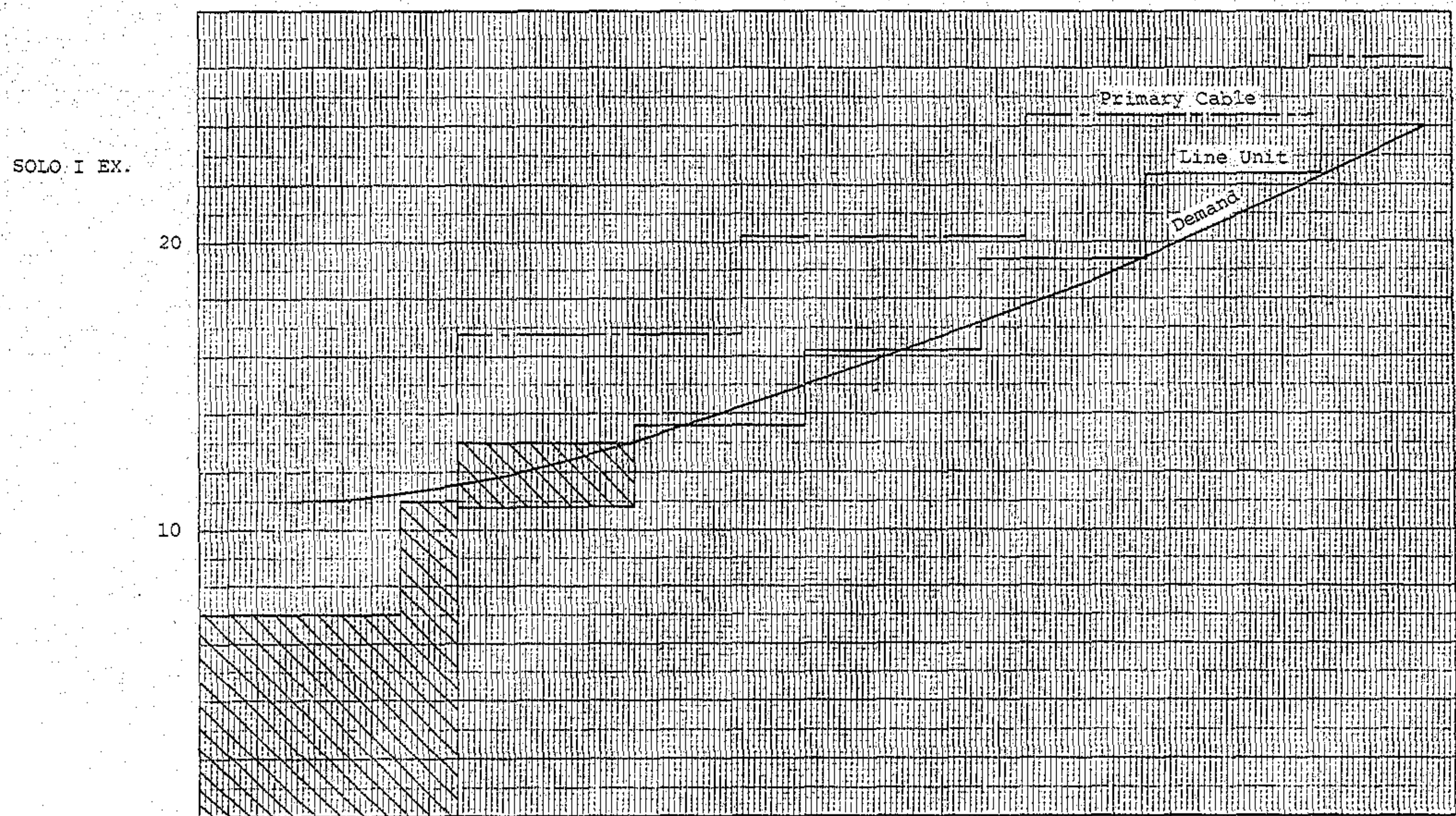
Year	1984	85	86	87	88	89	1990	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	2005
Demand		1.3			2.4		3.2			4.4		5.6			7.0		8.2			10.3		11.5
Line Unit					2.3			3.5			5.7			7.5			10.5			11.5		-
Primary Cable					4.6					7.7					11.3					12.7		
Remark																						

Figure AN-3-21 Installation Target of Mang Kang Exchange



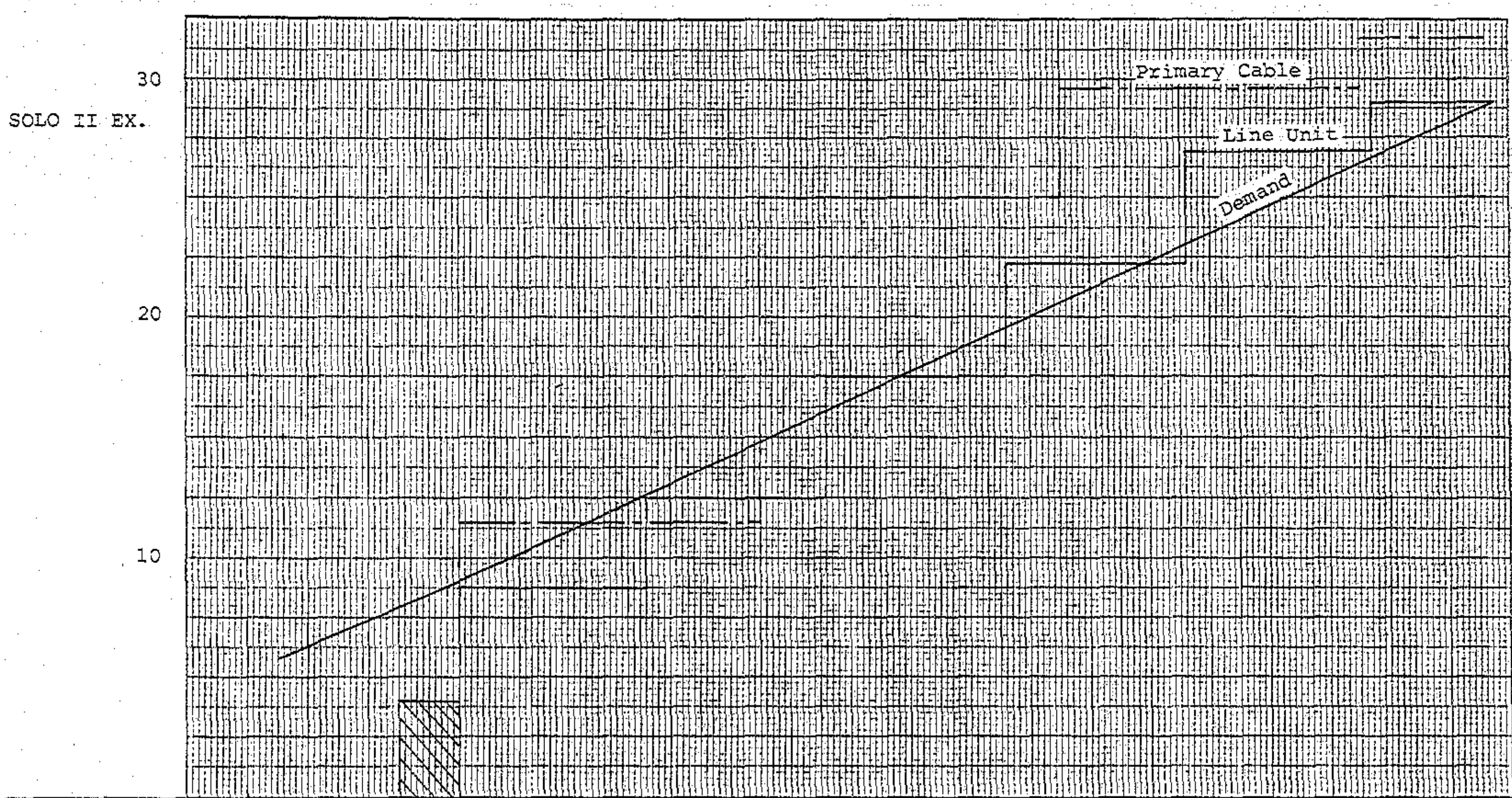
Year	1984	85	86	87	88	89	1990	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	2005
Demand		15.9			20.6		24.0			29.2		32.8			38.3		42.4			49.1		52.8
Line Unit	7.0	7.0	7.0	15.0	19.7			26.1			33.6			41.5			49.1			52.8		-
Primary Cable					28.1					45.2					54.0					58.1		
Remark					17.0 (Perumtel's Plan)																	

Figure AN-3-22 Installation Target of Solo Area



Year	1984	85	86	87	88	89	1990	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	2005
Demand		10.1			11.5		12.5			14.3		15.6			17.8		19.4			22.1		24.0
Line Unit	7.0	7.0	7.0	11.0	11.0			13.6			16.0			19.2			22.1			24.0		
Primary Cable					16.7					20.2					24.3					26.4		
Remark					13.0 (Perumtel's Plan)																	

Figure AN-3-23 Installation Target of Solo I Exchange



Year	1984	85	86	87	88	89	1990	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	2005
Demand		5.8			9.1		11.5			14.9		17.2			20.7		23.0			27.0		28.8
Line Unit				4.0	8.7			12.5			17.6			22.3			27.0			28.8		-
Primary Cable					11.4					25.0					29.7					31.7		
Remark					4.0 (Perumtel's Plan)																	

Figure AN-3-24 Installation Target of Solo II Exchange

ANNEX 4

COST COMPARISON OF TRANSMISSION SYSTEM

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and 34 Mbit/s Optical Fiber Cable System

ANNEX 4 COMPARATIVE STUDY OF TRANSMISSION SYSTEMS

1. System Selection Preconditions

(1) Transmission system to be taken up for comparative study be 2 Mbit/s cable system and 34 Mbit/s optical fiber cable system.

These two systems are chosen for comparison, from the viewpoint of transmission capacity in terms of the number of circuits which can be accommodated.

(2) Cable with metal screen to be used in 2 Mbit/s cable system be domestic product of Indonesia.

(3) Optical fiber cable and digital transmission equipment be imported products.

(4) For both systems, cable installation be in duct.

(5) No-repeater distance of optical fiber cable system be 20 km at maximum.

(6) Interface with switching equipment be digital primary group.

2. Comparative Study

Applicable distance limitations of both systems as compared in initial cost are in Figure AN-4-1.

The illustration shows that inter-exchange distance and number of circuits, wherein both systems are equivalent, are 16 - 18 km for the former and 1,920 CH or more for the latter. That is to say, for the section where inter-exchange distance and number of circuits fall below the figures quoted, 2 Mbit/s cable system commands advantage. Therefore, in this project, the number of circuits and distance between exchange make it preferable to adopt 2 Mbit/s cable system.

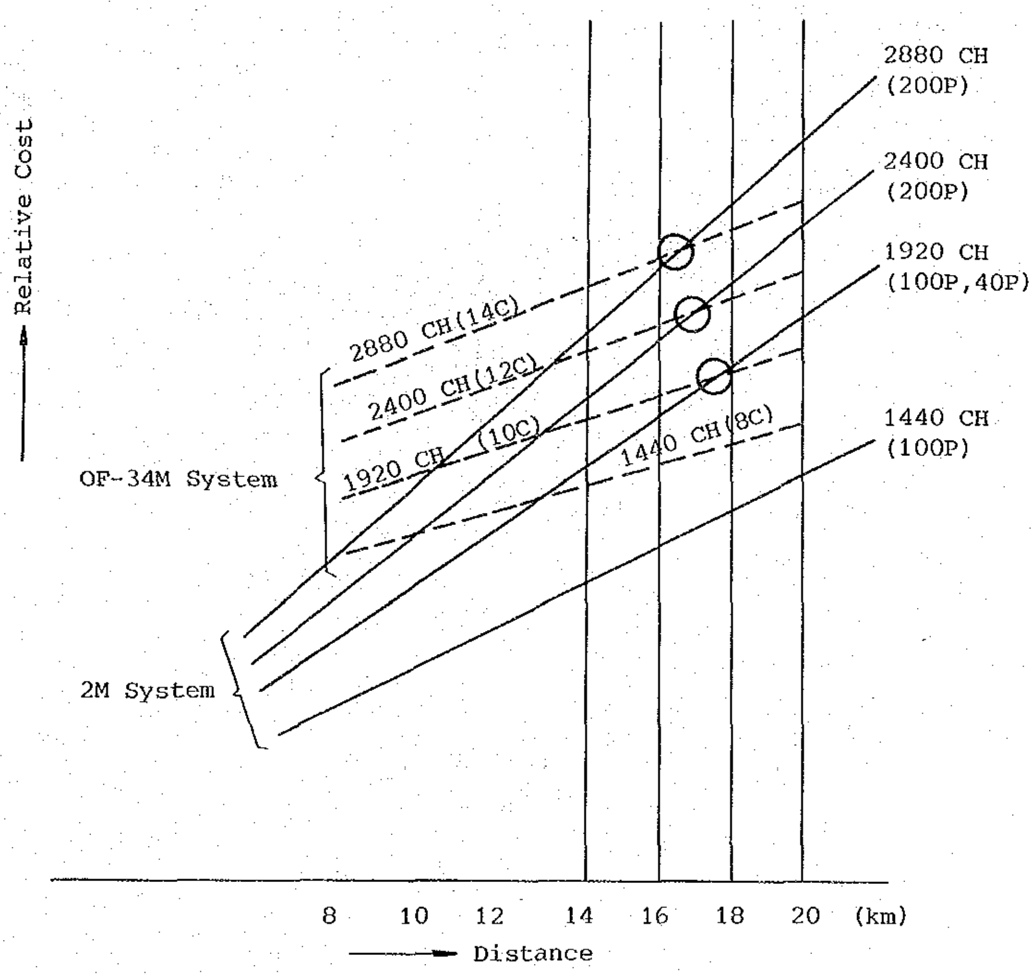

Figure AN-4-1 Cost Comparison of 2 Mbit/s Cable System and 34 Mbit/s Optical Fiber Cable System

ANNEX 5

POWER CONSUMPTION

5. Power Supply Plan

Power supply plan to feed transmission equipment, classified by exchanges and by project phase years (1993, 1998 and 2005), is in Table AN-5-1.

Table AN-5-1 Power Supply Plan

Unit:Watt

Exchanges \ Year	1993	1998	2005
Centrum I	670	970	2,010
Centrum II	4,030	4,780	5,510
Padang Bulan	140	140	150
Cinta Damai	140	210	240
Pulau Brayan	150	220	290
Tanjung Mulia	230	270	390
Labuhan	150	150	160
Belawan	90	90	90
Suka Ramai	200	260	330
Simpang Limun	140	190	240
Semarang I	2,050	1,480	1,930
Tugu	150	210	220
Mang kang	140	140	140
Genuk	140	140	140
Semarang II	1,340	1,400	1,520
Majapahit	160	170	190
Banyumanik	140	170	190
Solo I	510	590	320
Solo II	140	140	140

ANNEX 6

STUDY ON REFERENCE EQUIVALENTS OF DIGITAL/ANALOGUE MIXED NATIONAL NETWORK

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ANNEX 6 TRANSMISSION LOSS ALLOCATION IN DIGITAL/ANALOG NETWORK

1. Overview

Digital subscriber telephone functions are twofold: 4-wire switching function and 2-wire analog interface function with subscriber's line. Therefore, at the time of call connection, digital subscriber telephone organizes 4-wire loop circuit. In this case, 4-wire loop circuit stability and echo hold a great deal to do with transmission loss of circuit.

Subscriber trunk of digital subscriber telephone possesses 2-wire/4-wire hybrid terminator that connects 2-wire subscriber's line and 4-wire switching circuit. Therefore, balance return loss at this terminator is serously related to 4-wire loop circuit loss.

2. Balance Return Loss

For subscriber system impedance in Indonesia, data are not available. Therefore, to select the types of subscriber's cable and telephone to use, theoretical balance return loss calculation is made, based on presumed PERUMTEL specifications.

2-1 Subscriber Loop Impedance

Subscriber loop impedance can be expressed as under.

$$Z_1 = Z_0 \frac{Z \cdot \cosh r\ell + Z_0 \cdot \sinh r\ell}{Z \cdot \sinh r\ell + Z_0 \cdot \cosh r\ell} \quad \cdots\cdots\cdots \quad (1)$$

where

Z_0: Characteristic impedance of line

Z: Telephone set impedance

r: Propagation constant of line

ℓ: Line length

Voice frequency band impedance, even if calculated without regard to non-loaded cable inductance and conductance, is of sufficient accuracy for telephone network plan. Therefore, secondary constant of cable can be expressed as under.

$$Z_0 = \left|\sqrt{\frac{\gamma}{\omega C}}\right| \angle -\frac{\pi}{4}$$

Hence,

$$R_0 + j X_0 = \sqrt{\frac{\gamma}{2 \omega C}} - j \sqrt{\frac{\pi}{2 \omega C}} \quad \text{(ohms)}$$

$$\gamma = \alpha + j \beta = \sqrt{\frac{\omega C \gamma}{2}} + j \sqrt{\frac{\omega C \gamma}{2}} \quad \text{(Np/Km; radians/km)}$$

In utility unit,

$$R_0 = - X_0 = 8920.6 \sqrt{\frac{\gamma}{f C}} \quad \text{(ohms)} \qquad \cdots\cdots\cdots\cdots \quad (2)$$

$$\alpha = \beta = 5.6 \times 10^{-5} \sqrt{f C \gamma} \quad \text{(Np/Km; radians/km)} \qquad \cdots \quad (3)$$

Provided

γ: d.c. loop resistance (ohm/km)

C: Mutual capacitance (nF/km)

f: Frequency (Hz)

Particulars of cable and telephone to be adopted are assumed as under.

a) Cable

Conductor Diameter	Loop Resistance	Mutual Capacitance
0.4 mm	300 ohms/km	50 nF/km
0.6 mm	130 ohms/km	50 nF/km

b) Telephone

Desk telephone
(PERUMTEL specifications: No. 01/SO1/Subditpran/1/80)
Impedance: 600 ohms, nominal

Result of Z_1 calculated by expressions (1), (2) and (3) is in Figure AN-6-1.

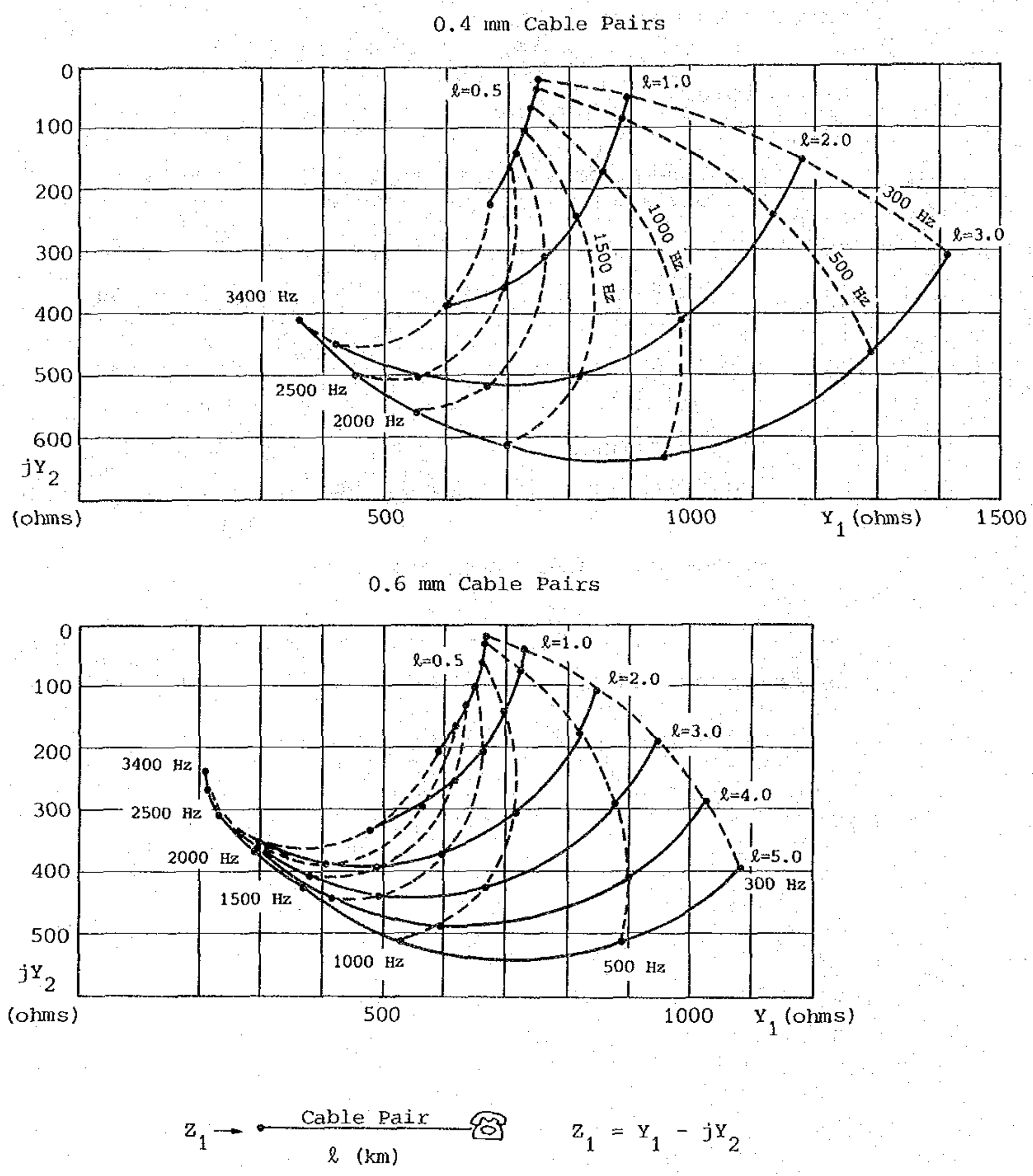


Figure AN-6-1 Impedance Characteristics of Subscriber Line

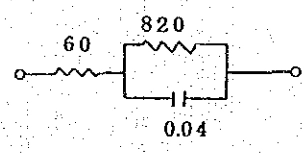
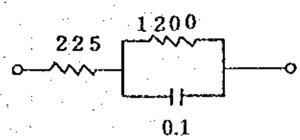
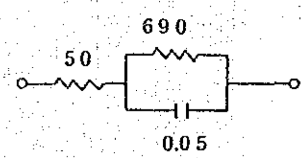
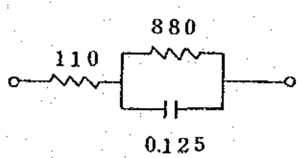
2-2 Balance Return Loss

2-wire/4-wire hybrid terminator's 2-wire point to line balance return loss (BRL) can be expressed as under.

$$BRL = 20 \log \left| \frac{Z_B + Z_1}{Z_B - Z_1} \right| \text{ (dB)}$$

where Z_1 denotes subscriber loop impedance and Z_B denotes balancing network circuits, two types are considered, one to use 0.4 mmϕ cable and the other to use 0.6 mmϕ cable. Refer to illustration below.

(Unit: Resistance in ohm; capacitance in μF)

	For Short Distance Subscriber		For Middle, Long Distance Subscriber	
0.4 mm Cable	A		B	
0.6 mm cable	a		b	

Balance return loss calculation results for 0.4 mmϕ and 0.6 mmϕ cable pairs are in Figure AN-6-2. Calculation result for 600 phms balancing network as special case is in Figure AN-6-3.

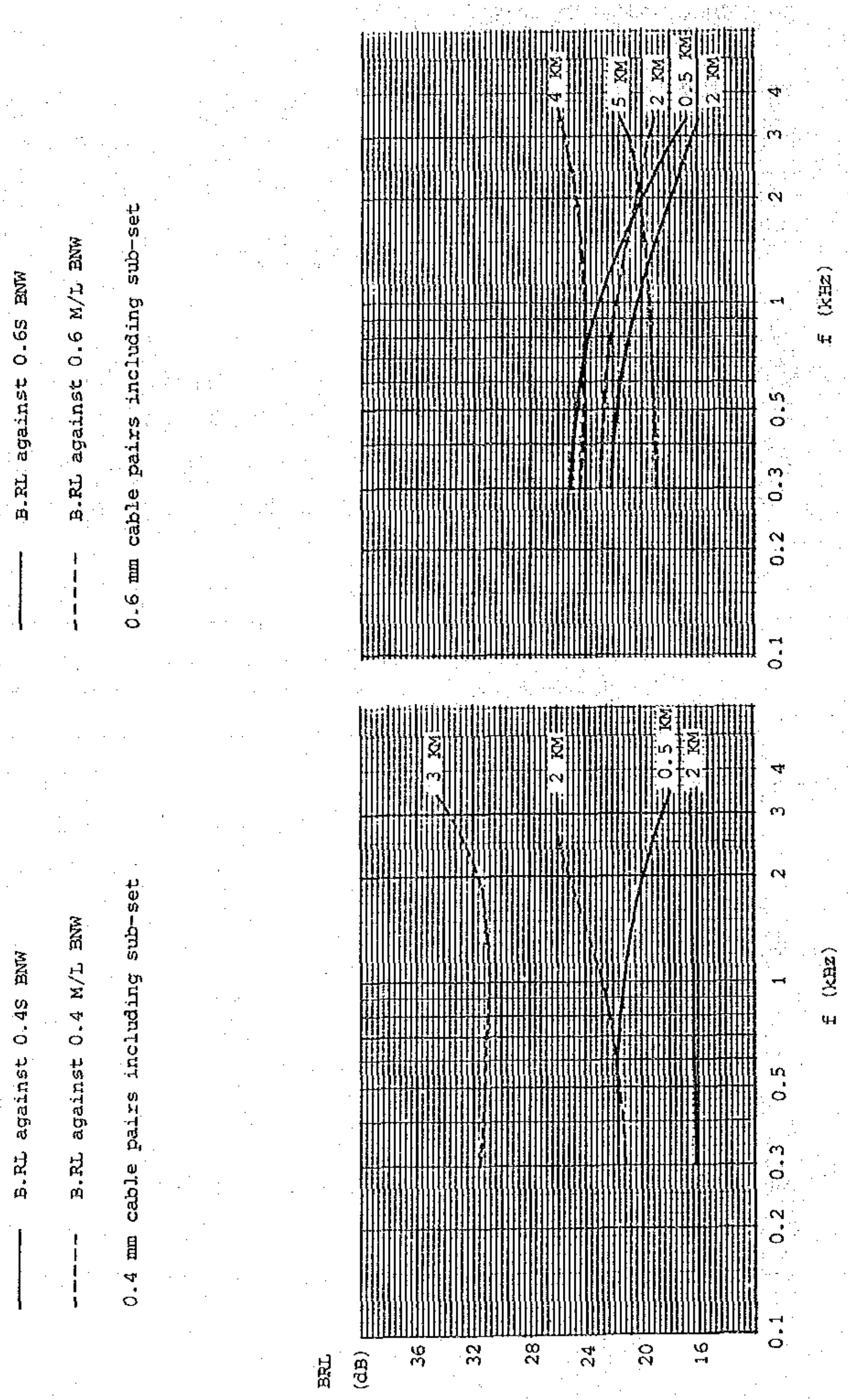


Figure AN-6-2 Balance Return Loss Calculation (0.4 mm Cable and 0.6 mm Cable)

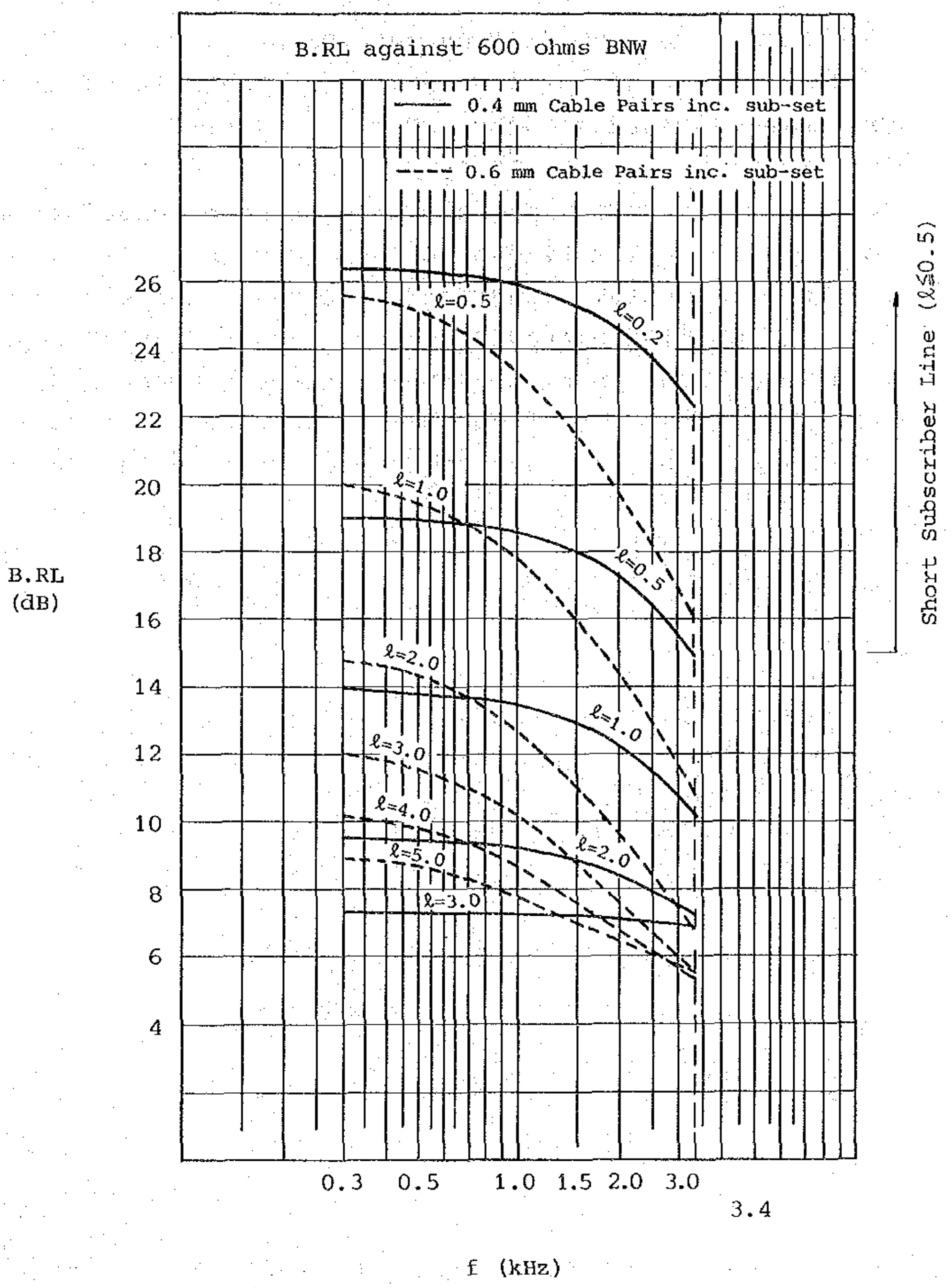


Figure AN-6-3 Balance Return Loss Calculation (600 ohm Balancing Network)

2-3 Echo Balance Return Loss

Echo balance return loss is mean power ratio in 50 Hz - 2,500 Hz band, of balance return loss calculated in the preceding paragraph 2-2.

For individual balancing networks, echo balance return loss of 16 dB or more can be secured within the range of 0.5 km - 5 km cable length and, for 600 ohms balancing network, withinthe range of 0 km - 0.5 km cable length. This is evident in Figure AN-6-2 and Figure AN-6-3.

3. Stability and Echo

3-1 Intra-Exchange Connection Call Circuit

4-wire loop line length for inter-terminal exchange connection in multi-exchange area and for intra-exchange connection is extremely short, compared with loop line length required for long distance connection. Therefore, when determining transmission loss, stability rather than echo becomes deciding factor.

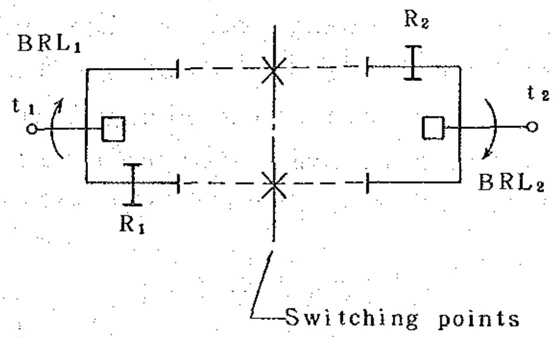
From the view point of stability, conditional equation as under takes effect for the example illustrated below.

$$(R_1 + BRL_1) + (R_2 + BRL_2) \geqq 2(10 + n)$$

where

n: Number of analog 4-wire circuits

R_1, R_2: Transmission loss between 4-wire and 2-wire circuits (analog pad and 2-wire/4-wire terminator loss)



BRL in the above equation denotes mean stability balance return loss. However, statistical data concerning BRL are not available. Therefore, instead of BRL, minimum value obtained from Figure AN-6-2 and Figure AN-6-3 is used.

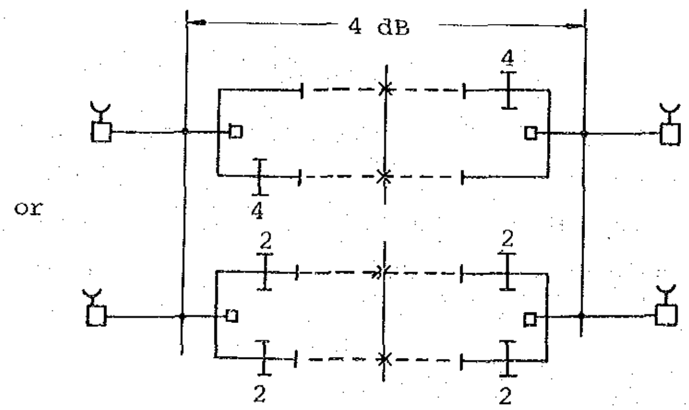
Although the minimum value obtained is 15 dB, this 15 dB minus 3 dB as margin, i.e., 12 dB, is used as mean value. Conditional equation is

$$R_1 + R_2 \geqq -4$$

If $R_1 = R_2$,

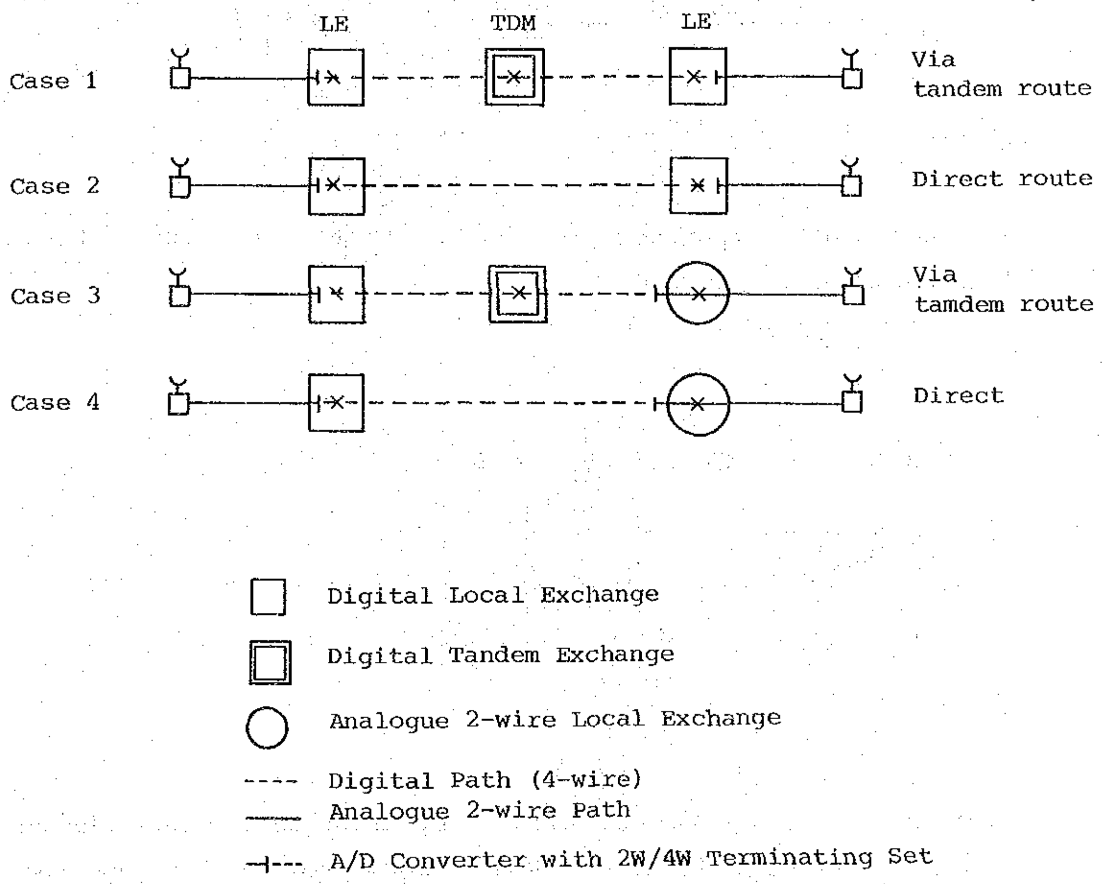
$$R_1 \geqq -2$$

Consequently, for $t_1 - t_2$ transmission loss, 0 dB can be used practically from the viewpoint of stability. However, receiver echo, which exerts no much influence on telephone circuit, affects non-voice communication (e.g., facsimile and data transmission) circuit a great deal. For instance, receiver echo deteriorates facsimile transmission performance. If such services as facsimile and data transmission are provided via digital local switching equipment, $t_1 - t_2$ minimum transmission loss exceeds 3.3 dB according to the standard in Japan. This means that for practical value, 4 dB or even more is necessary. This time, 4 dB is adopted as temporary value as in the illustration below. However, from now forward, intra-exchange connection system transmission loss must be determined in due consideration of electrical characteristics and specifications of facsimile equipment, data transmission terminal equipment, etc., to be newly introduced.

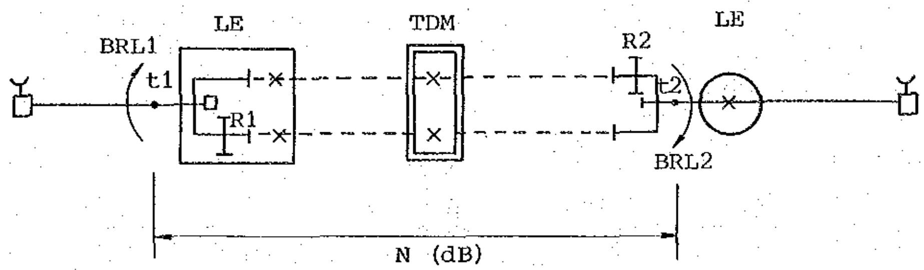


3-2 Inter-Terminal Exchange Connection Call Circuit in Multi-Exchange Area

Circuit configuration at initial stage of digital system introduction will be as illustrated below.



For stability balance return loss at 2-wire analog switching equipment side as in Case 3 and Case 4, about 6 dB in mean value can be expected. Equivalent circuit formation is illustrated below.



Conditional equation for stability of the above circuit formation is as under.

$$R_1 + R_2 + BRL_1 + BRL_2 \geqq 2\ (10 + n)$$

If $BRL_1 = 12$ dB and $BRL_2 = 6$ dB,

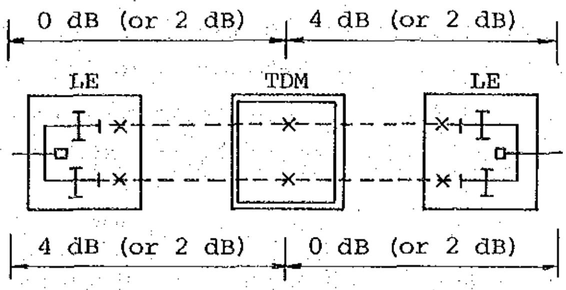
$$R_1 + R_2 \geqq 2$$

If $R_1 = R_2$,

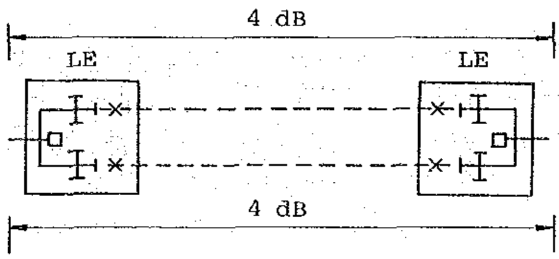
$$R_1 \geqq 1$$

From the viewpoint of stability, minimum transmission loss is 1 dB. When non-voice communication services are taken into consideration, allocation of minimum transmission loss of 4 dB to those service circuits is desirable. This transmission loss allocation is illustrated below.

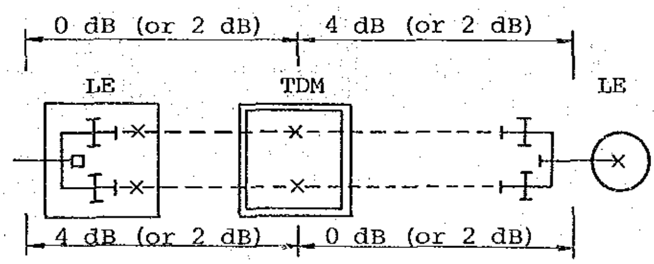
Case 1
(via tandem route)



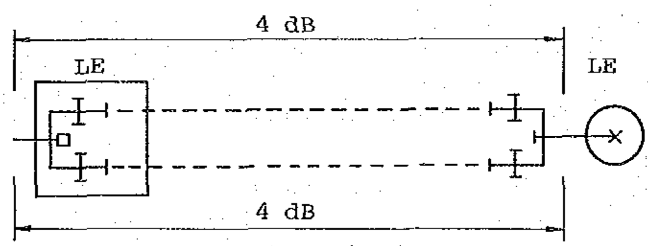
Case 2
(direct route)



Case 3
(via tandem route)

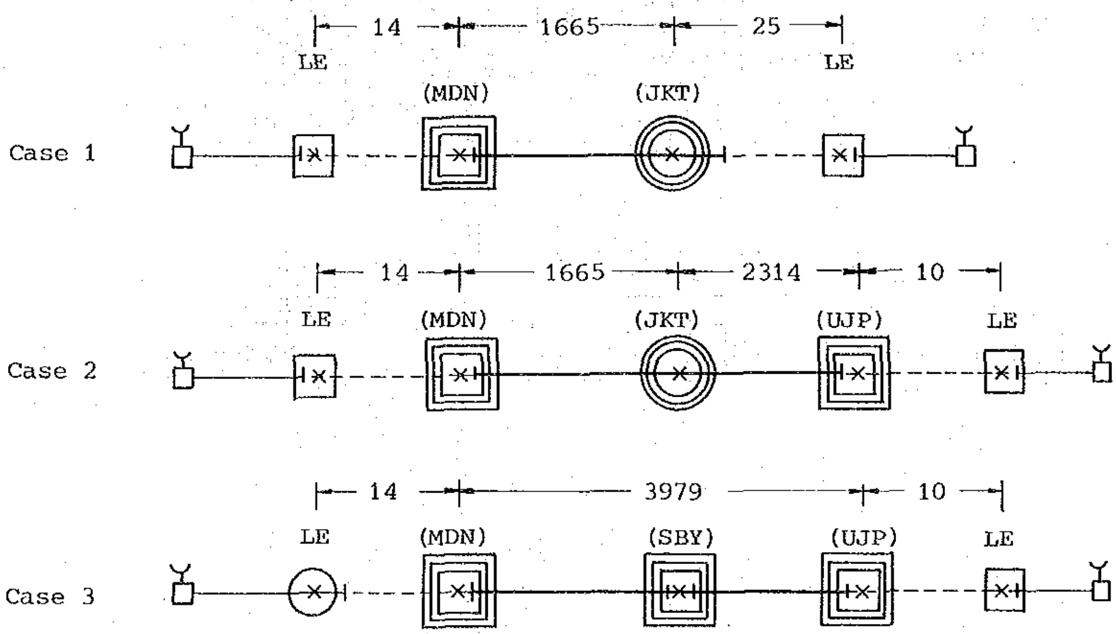


Case 4
(direct route)



3-3 Long Distance Connection Call Circuit

Circuit configuration at initial staeg of digital system introduction will be as illustrated below.



Note: Figures indicate the transmission line length in kilometer

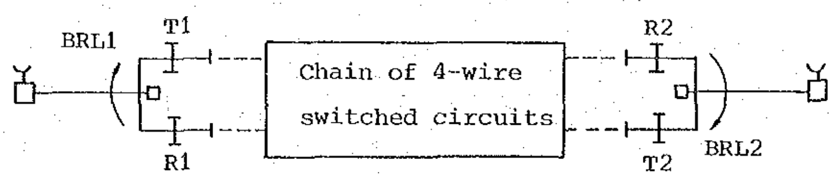
Legend:

- Analogue 2-wire Local Exchange
- Analogue Trunk 4-wire Exchange
- Digital Local Exchange
- Digital Trunk Exchange
- Analogue 4-wire Circuit
- Analogue 2-wire Cirucit
- Digital Circuit
- A/D Converter without 2W/4W Terminating Set
- A/D Converter with 2W/4W Terminating Set
- Telephone Set

3-3-1 Stability

(1) Mean Value of 4-Wire Loop Loss

For long distance connection call circuit, equivalent circuit formation is as illustrated below.



By CCITT Rec. G. 122 (Yellow Book, 1980), mean value of 4-wire circuit connection system loop loss should be 2 (10 + n) dB or more. That is to say, the requirement hereunder should be satisfied.

$$(R_1 + BRL_1 + T_1) + (R_2 + BRL_2 + T_2) \geqq 2\ (10 + n)\ dB$$

Conditions to 4-wire loop loss mean fo Case 1, Case 2 and Case 3 are as under.

Case 1: $2\ (T + R) + (BRL_1 + BRL_2) \geqq 22$ dB

Cases 2 & 3: $2\ (T + R) + (BRL_1 + BRL_2) \geqq 24$ dB

For Case 1 and Case 2, if T = 0 dB, R = 4 dB and $BRL_1 = BRL_2 = 12$ dB, the foregoing requirement is satisfied.

For Case 3, when 2-wire/4-wire terminator's 2-wire switching equipment side stability balance return loss mean is 6 dB and if T = 0 dB, R = 4 dB and $BRL_2 = 12$ dB, the requirement is satisfied.

(2) Minimum Value of 4-Wire Loop Loss

The requirement whereby to attain minimum value of 4-wire loop loss, based on CCITT Rec. G. 122 (Yellow Book, 1980) and in accordance with equivalent circuit formation as in the preceding paragraph (1), is as under.

$$2(T + R) + (BRL_1 + BRL_2) \geqq 2(6 + \sum_{i=1}^{n} x_i) \text{ (dB)}$$

where

x_i: Sum of nominal values of both transmission directions of the first circuit

n: Number of 4-wire circuits

4-wire loop loss value becomes minimum when the called party's 2-wire side is in the released state, i.e., when $BRL_2 = 0$. In this case, the foregoing conditional equation becomes as under.

$$2(T + R) + (BRL_1) \geqq 2(6 + \sum_{i=1}^{n} x_i) \text{ (dB)}$$

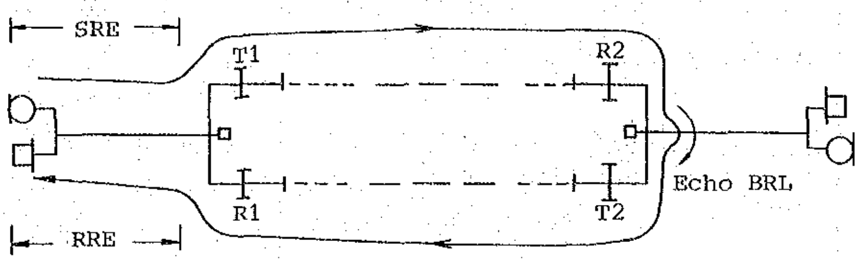
When T = 0 dB, R = 4 dB and x_i = 0 dB,

$$8 + BRL_1 \geqq 12 \text{ dB}$$

Therefore, the requirement is satisfied.

3-3-2 Echo

Talker's echo route and reference equivalent are as under.



Echo route reference equivalent =

$$SRE + T_1 + R_2 + \text{Echo BRL} + T_2 + R_1 + RRE$$

For relationship between minimum reference equivalent on echo route and single direction propagation time, CCITT Rec. G. 131 is applied.

For propagation time calculation, propagation time by transmission system provision of CCITT Rec. G. 144 is used. That is to say,

Terrestrial radio system (analog or digital)	4 ms/1,000 km
FDM channel modulator or demodulator	0.75 ms/set
PCM coder or decoder	0.3 ms/set
Digital repeater switches	0.45 ms/exchange
Digital local switches	1.5 ms/exchange

Propagation time and allowable echo route reference equivalent in Cases 1, 2 and 3 circuit formations are as under.

		Case 1	Case 2	Case 3
Single direction propagation time (ms)		13.4	24.1	23.6
Number of analog links		1	2	2
Allowable echo route reference equivalent (dB)	10%	21.0	27.6	27.5
	1%	28.0	34.5	34.3

Reference equivalent calculation above is from Figure AN-6-4 (CCITT Rec. G. 131, Figure 2/G. 131).

In regard to minimum value of talker side subscriber loop sending reference equivalent, CCITT Rec. G. 121 provides as under.

> For national circuit section of international connection system, revised reference equivalent up to analog international switching point shall be 7 dB or more.

This revised reference equivalent corresponds to reference equivalent of 5.5 dB. (Refer to Figure AN-6-5.) If T = 0 dB, minimum sending reference equivalent (SRE) is 5.5 dB. This minimum reference equivalent can be realized by introducing sending volume control type telephone or pad insertion type telephone.

Figure AN-6-5 indicates that when SRE = 5.5 dB, RRE is -2.5 dB.

Case where sum of single direction propagation time is 24.1 ms and sum of echo route reference equivalent is 31.0 dB assumes position below 1% curve and above 10% curve in Figure AN-6-4. This fact signifies more than 1% and less than 10% probability, hence "unsatisfactory" evaluation.

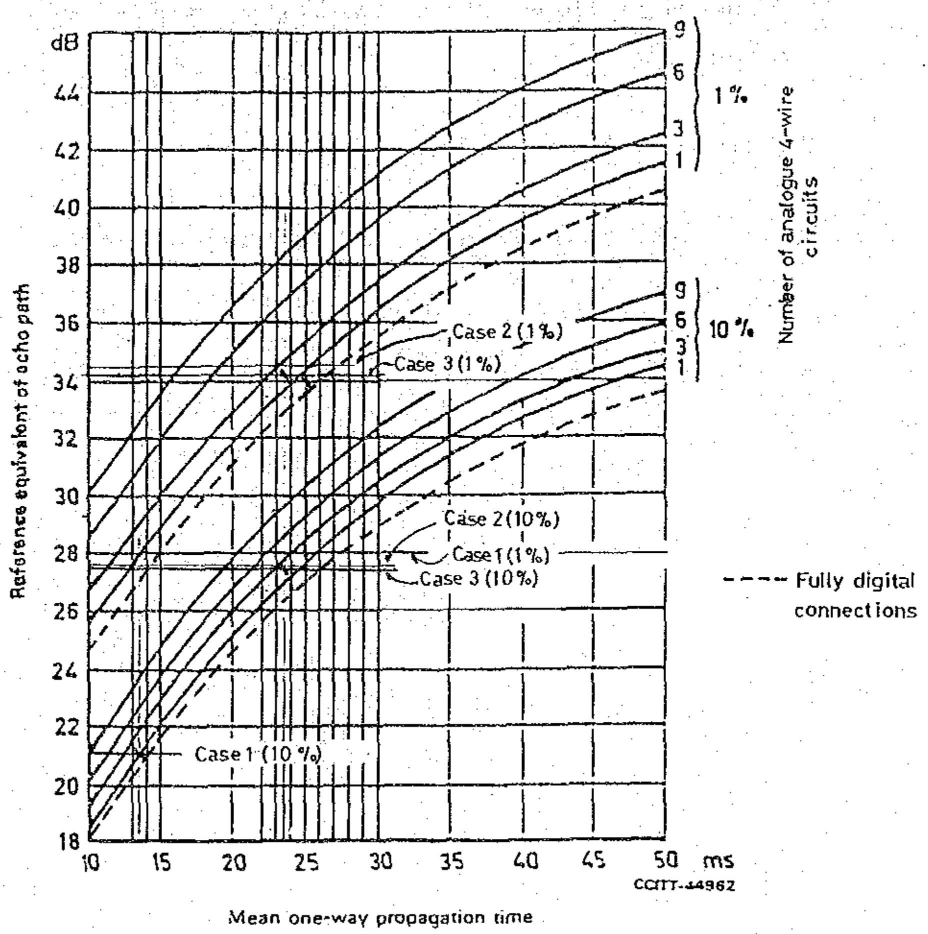
Conclusion is as under.

Means to attain long term echo objective of 1% by this circuit formation is

a) To use echo controller

or

b) To increase echo route loss



Note 1 – The percentages refer to the probability of encountering objectionable echo.

Note 2 – The reference equivalent of the echo path is here defined as the sum of:

- the values of the transmission loss in the two directions of transmission between the 2-wire end of the talking subscriber's line in the terminal local exchange and the 2-wire terminals of the 4W/2W terminating set at the listener's end;
- the mean value of the echo balance return loss at the listener's end; and
- the simultaneous-minimum sending and receiving reference equivalents of subscribers' telephone sets and lines at the talker's local exchange.

Figure AN-6-4 Echo Tolerance Curves

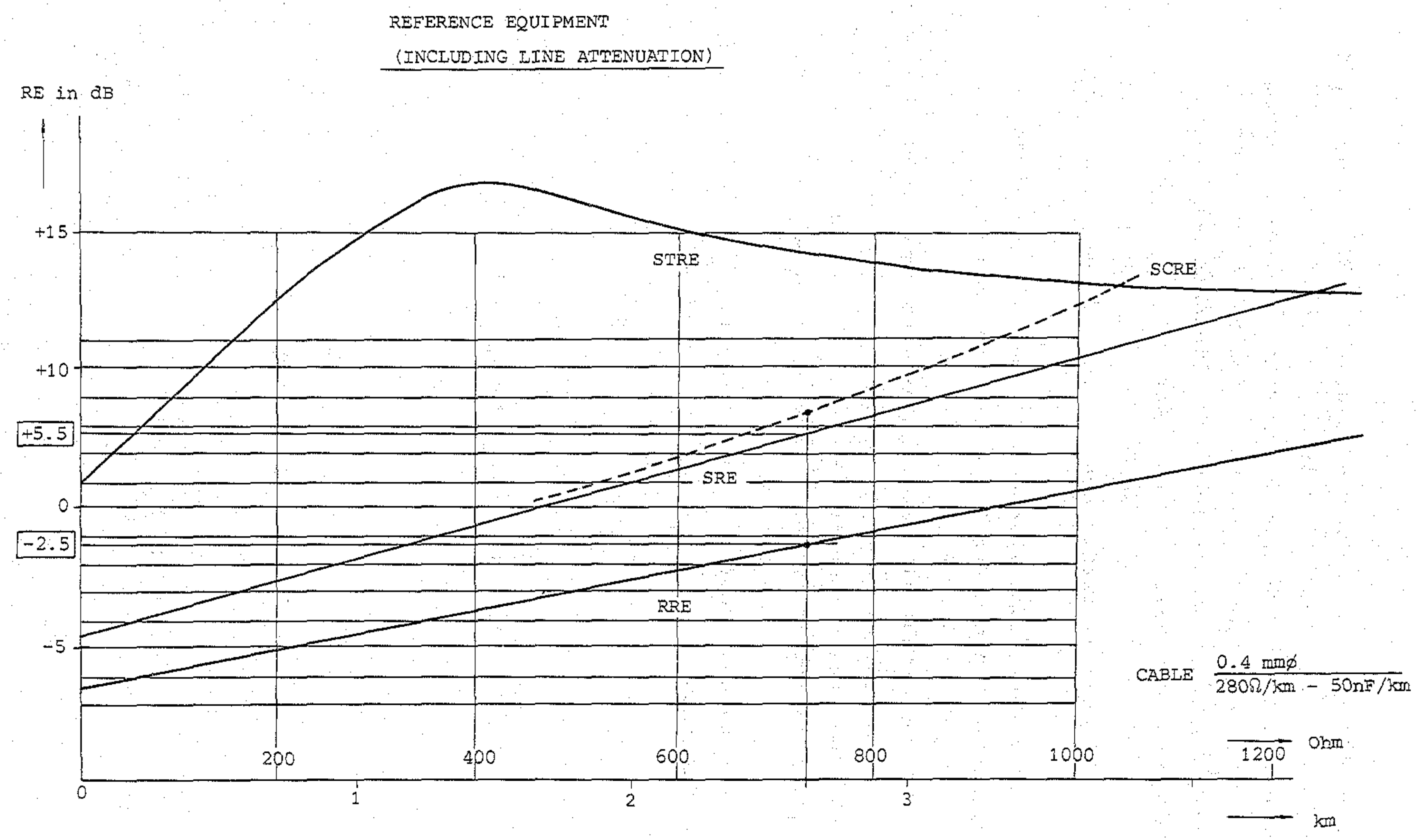


Figure AN-6-5 Extracted From PERUMTEL Specifications

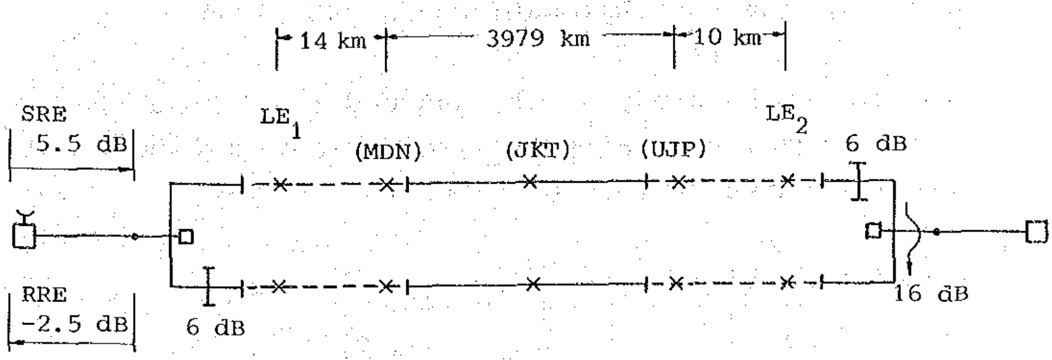
When SRE = 5.5 dB, RRE = -2.5 dB, $T_1 = T_2 = 0$ dB, $R_1 = R_2 = 6$ dB and echo BRL = 16 dB are substituted in the aforementioned echo route reference equivalent expression, 31 dB is obtained. Relationship between echo route reference equivalent and allowable echo route reference equivalent is as under.

31 dB ≧ allowable echo route reference equivalent

Circuit formations which do not satisfy the above requirement are Cases 2 and 3 where echo risk is 1%.

CCITT recommends 1% echo risk as long term objective and 10% echo risk as short term objective. Therefore, if 10% echo risk is adopted at initial stage of digital system introduction, echo controller is not necessary.

Figure AN-6-6 presents typical example of Figure AN-6-4 application.



Distance from LE_1 to LE_2	4,003 km
Sum of single directino propagation time	24.1 ms
1) Terrestrial radio system (4,003 km)	16.0 ms
2) FDM channel modulator/demodulator (2 sets)	3.0 ms
3) PCM coder (2 sets)	1.2 ms
4) Digital repeater switches (2 exchanges)	0.9 ms
5) Digital local switches (2 exchanges)	3.0 ms
Subscriber handset reference equivalent (5.5 - 2.5 = 3.0)	3.0 dB
2-wire to 2-wire transmission loss at LE	6.0 dB
Echo balance return loss	16.0 dB
No. of analog 4-wire circuits	2
Sum of echo route reference equivalent	31.0 dB

Figure AN-6-6 Example Application of Echo Path Reference Equivalents

4. Transmission Loss Allocation Plan

The foregoing study shows that under all conditions established, echo affects more seriously than stability the transmission loss of circuits.

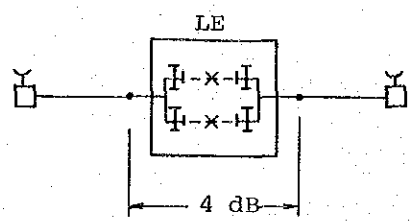
Remedial decisions are

- o For local call connection, to assign 4 dB to R pad (or 2 dB to each of T and R pads)
- o For long distance call connection, to assign 6 dB to R pad (or 3 dB to each of T and R pads)

This arrangement presupposes introduction of pad-controlled telephones.

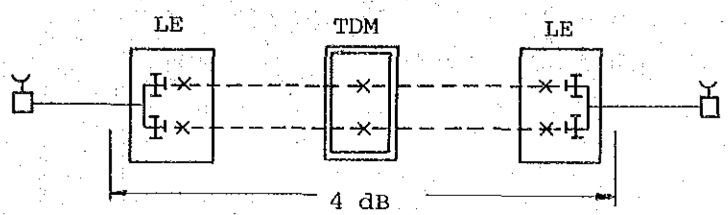
Transmission loss allocation plan resulting from this study appears below.

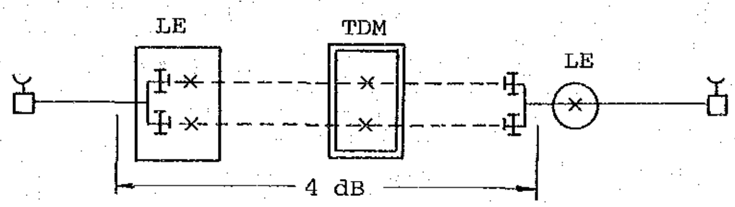
(1) Circuit Formation of Intra-Exchange Connection Call



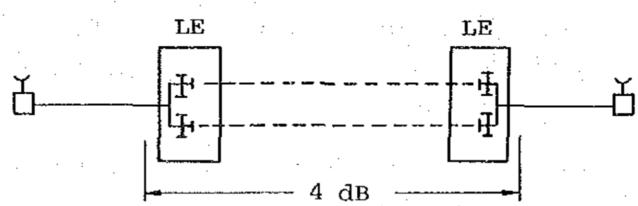
(2) Circuit Formatino for Inter-Terminal Exchange Connection Call in Multi-Exchange Area

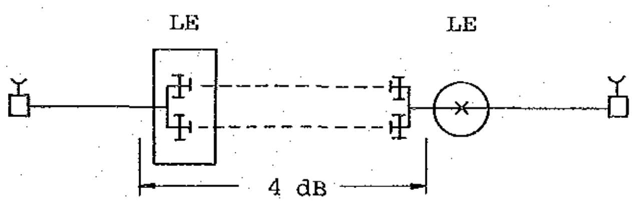
a) Via Tandem Exchange



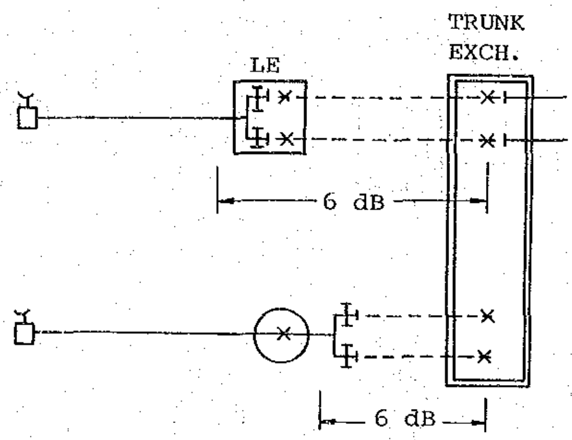


b) Through Route





(3) Circuit Formation for Long Distance Connection Call



5. Conclusion

This study is on the assumption that all the concepts considered ar realizable. For example, the mean value of echo balance return loss is set at 16 dB, the simultaneous minimum reference equivalent of subscriber's loop at 3 dB, and the value of R pad at 4 dB for within-area call connection and at 6 dB for long distance call connection.

However, this study, not being based on actual data of subscriber's loops, is just one approach to transmission planning.

For the formulation of transmission plan in a real sense, prime requisites are, among other things. Digital local exchange equipment established on practical basis and fact-finding about subscriber's line impedances in all parts of the country.

Such transmission plan is not of the nature that can be studied in the transmission network improvement plan contemplated by this project.

Transmission plan that may establish the standard of national telecommunication network should be further studied and designed in an ad hoc project to serve such purpose.

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