CHAPTER 3

SHORT-TERM EXPANSION PROGRAM

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3.1. Works in Short-term Expansion Program

3.1.1. Estimation of Construction Cost

(1) Construction Unit Price of Transmission Line
(Foreign Currency Portion)

(a) Calculation method

Unit price of construction (/KM) of transmission line (Foreign currency portion) is composed as follows:

Unit price = Purchase cost of the main equipment + Accessory cost + Other necessary cost for construction such as tool and instrument cost, vehicle cost, tower test cost, guidance fee

As the unit price estimated in this stage is for Feasibility Study, the following simplified formula is applied.

$$\text{Unit price} = [\ \Sigma Nn \times An\ (1 + \alpha n)\ ]\ (1 + \beta)$$

Nn : Quantity of main equipment (/Km)
An : unit price of main equipment
αn : price ratio of accessory to main equipment
ß : price ratio of "the others" to total materials

(b) The quantity of main equipment (Nn)

Main equipment of transmission line includes the towers, conductors, earth wires and insulators.

As the specifications to be applied to this estimation are the same as those of East Java Transmission Line Project 3rd stage, the quantity per km for this East Java Project 3rd stage was considered as a standard for this construction estimation. In consideration of the above, only the transmission lines of more than 10 km in East Java Transmission Line Project 3rd stage are used for this estimation.

i) Tower

Conductors for the tower applied are as follows:

- 150 kV 330 mm^2 A.C.S.R. Twin conductors
- 150 kV 330 mm^2 A.C.S.R. Single conductor
- 70 kV 300 MCM A.C.S.R. conductor

The longer the route of length becomes, the easier the route selection is. In this case, the tower weight per km will decrease. (See Fig. 3.1-1) Many crossing objects being found in the residential area, the tower is averagely 4 to 5 m taller than usual and the weight will increase, accordingly.

ii) Conductor and Earth Wire

In general, the 3% increase in length has to be considered as an allowance for the total route length of transmission line. This allowance is for the sag of conductor and for the difference between supporting levels of conductors and the length of jumper wire.

iii) Insulator

The necessary quantity of insulators per km is obtained by the number of towers both in suspension type and tension type. Which string is to be used for insulators, single string or double string, is, in general, decided by the crossing frequency of main crossing objects.

However, in consideration of the strength, double string should be in use as the tension string of 150 kV 330 mm^2 twin transmission line.

Based on the data of East Java Project 3rd Stage, the ratio of tension/suspension string in tower and the characteristics of mean span length are shown in Fig. 3.1-2 and Fig. 3.1-3., respectively.

Combining the above factors, the tower number per km of each type such as suspension type and tension type can be calculated by the route length of transmission line. (Fig. 3.1-4).

Fig. 3.1-5. shows the ratio of double string to total string.

The above ratio adopted in this calculation is 1/4 in the usual area and 1/3 in the residential area, respectively.

(c) Unit price of main equipment (An)

The unit price of the main equipment is based on the price as of April 1, 1984. Estimation was made to each unit price of the component of the main equipment, as seen below:

i) Tower

In general, the cost of tower is much influenced by the manufacturing weight per tower type.

The relation between the weight/type and the unit price of tower was obtained from the recent examples of two projects in Indonesia and one project in other country. (See Fig. 3.1-6)

From this Fig. 3.1-6, the weight per tower type can be represented almost straight line by log scale.

Besides, it is also found that the relation between the weight/type and the unit price of tower can be fitted to this straight line, when the estimated escalation for succeeding 4 (four) years is added to the unit price @US$683/ton of East Java Project 3rd Stage.

In this project, as the weight per tower type is estimated around 300 tons, US$880/ton is considered appropriate as the unit price of tower. But finally, @US$900/ton was decided as the unit price, taking into account the allowance of price fluctuation.

ii) Conductor, earth wire and insulator string

Each unit price of these materials was obtained from the price data of Acceleration Project for East Java and Surabaya City Power Distribution Project.
With regard to the price comparison with these data, the amount adopted is shown in form of "ESTIMATED" in Table 3.1-1.

(d) Estimation of price ratio of accessory to main equipment (αn)

The total unit price of accessory can be obtained by summing up the unit prices of each accessories.

In this feasibility study, however, the unit price is estimated for simplicity, by multiplying the unit price of main equipment by some ratio (αn). Because the route of transmission line has not been decided in this F/S stage and the price of accessory is smaller by far than the amount of main equipment. The components of the accessory and the ratio of accessory to main equipment actually adopted in the recent PLN's projects and East Java Project 3rd Stage are shown in Table 3.1-2. As out study found no problems in these figures, the ratio in East Java Project 3rd Stage was adopted to the unit price estimation of accessory.

(e) Estimation of the price ratio of "the others" to total equipment (β)

The unit price included in "the others" is the amount required generally for the project execution. The contents thereof and the result of ratio estimate are shown as follows:

i) Tool and instrument

As the tools related to the tower foundation construction work are owned by local contractor, only the tools of stringing work were taken into consideration.

In East Java Project 3rd Stage, the stringing tools were procured in large quantities. As the said tools had been re-used in later projects such as East Java, Central Java and relative projects in Bali Island, the most of these tools are not available any more.

Threrfore, the procurement of new tools is considered in this estimation.

ii) Vehicles

To be estimated are the truck with crane for heavy duty, small truck and 4 (four) wheels drive small truck. Same as the tool for construction work, vehicles were also procured in large quantities in East Java 3rd Stage. These vehicles are at the renewal time and are planned to be used for the maintenance in Madura Island in the future. By this reason, the cost of vehicles is also considered in this estimation.

The total amount of tool and vehicles were estimated to be 15% of total material cost, same as East Java Project 3rd Stage.

iii) Cost of tower loading test

Considering the project scale, two types of test; suspension string tower test and tension string tower test are considered appropriate to be performed.

The design criteria used in this F/S stage are the same as East Java Project 3rd Stage, and there were found some cases of tower loading test performed in the past. However, as the manufacturing maker will not be always the same one, the cost of tower load test is included in this estimation, with the ratio of 0.7% of total material cost.

iv) The guidance fee of manufacturers

The guidance work by manufacturers includes the guidance in tower processing (change of leg extension in mountain) and stringing work. The cost thereof is not considered in the estimation, because of very little possibility of guidance work.

From the above consideration, 15.7% was adopted as the price ratio of "the others" for this estimation, to be *a factor of total unit price of the construction equipment.*

(f) The summing method of construction cost

The construction cost in foreign currency portion can be summed up according to the above description.

Table 3.1-3 shows the calculation case of transmission line (150kV 330 mm^2 A.C.S.R. Twin) in usual area (10 km, 30 km) and residential area (10 km).

(g) Comparison with the construction cost estimated in the above calculation and the cost of other projects

The summed result of construction cost (by voltage, by conductor type and by number of circuits) and the comparison with other projects are shown in Table 3.1-4, Table 3.1-5 and Table 3.1-6. As seen in these Tables, this estimation, based on the construction cost of East Java 3rd Stage Project, is almost fitted to the escalated amount as of April, 1984.

In comparison with other projects, for example, the cost in this estimation is lower than the unit cost of IBRD Power 15 Proposal and Gresik Project. The Tables also show that in Accelation Project, this estimated unit cost is close to the unit cost of 150 kV transmission line but lower than that of 70 kV transmission line.

(2) Construction Cost of Transmission Line (Local currency portion)

(a) Calculation method

Construction cost of transmission line (local currency portion) is composed of the construction cost, the land cost and the administration fee. As these items in local currency are procured by PLN, the breakdown data thereof could not be sufficiently obtained in the past.

For this estimation therefore, necessary data were collected and used in this stage. But the data are still in shortage, including large escalation ratio. It is recommended that data collection be continued to make more reliable estimation.

(b) Construction cost

i) Cost of tower construction

Obtained for the tower construction cost estimation are the cost data on foundation work and erection work of 150 kV transmission line in 1982, by kind of soil and by tower type.

Based on these data, the construction costs per tower and by voltage and by kind of soil were estimated and converted into the costs as of April 1984. (see Table 3.1-7)

ii) Cost of stringing work

Obtained data are those of the cost of stringing work in 150 kV single and double circuit, and 70 kV double circuit in 1982.

Based on these data the costs of stringing work by voltage, by number of circuits and by conductor type were estimated and converted into the costs as of April 1984. (See Table 3.1-8)

(c) Land Acquisition Cost

i) Land Purchase Cost

Land Purchase is limited to only steel tower site, of which area varies with the voltage. Unit price of purchase is divided into two parts; cost of the Surabaya City area including its surrounding and that of the other area out of Surabaya. Land Purchase has become difficult year by year. Purchased areas and purchase costs at the voltage of 150 kV and 70 kV are shown in Table 3.1-9.

ii) Right of Way

The Transmission Line route areas are, in principle, fully compensated. However, for the estimation the areas to be compensated are considered at 90% of all route areas with the necessary width for the lines. Namely, steel tower site and public lands, regarded as 10% of all route areas, are excluded in this cost estimation. The relation between route areas and compensation at 150 kV and 70 kV is tabulated in Table 3.1-10.

iii) Sums of land costs

Table 3.1-10 shows the sums of land purchase cost and right of way. According to this, as seen in the Table, the sums at Surabaya and surrounding is about 20% higher than those of the other places both at 150 kV and 70 kV.

(d) Administration Fee

Based on the administration fee of PLN itself in the similar construction works in the year of 1982, administration fee in this stage is estimated form the variation of voltage and kinds of works. The result is shown in Table 3.1-12.

(e) Comparison between the sum of estimated construction unit costs in this estimation and those costs of other projects

Table 3.1-13 shows the comparison between the sum of construction unit costs by voltage, by kinds of lines and by number of circuits and those costs of other projects. The cost estimation in this stage is based on the route length and kind of soil of the transmission lines, but those costs in other projects are generalized without classification by route length and kind of soil. Difference in each cost is rather wide between the estimated costs and those in other projects.

(3) Construction unit cost for substation

(a) Estimate method and Group Unit Costs

Foreign currency portion of substation construction costs consists of supply costs of machinery and construction materials to the Site, cost of construction guidance by foreign experts and so on. Local currency portion of those consists of purchase cost of construction materials, foundation works cost, transportation and installation cost, building construction cost, construction guidance cost of foreigners, land cost and so on. Substation construction cost is, at first, divided into some unit costs, called "group unit costs" for estimation. Then, substation construction cost is estimated by summing up the group unit costs.

It is very difficult to compute the group unit costs with concrete and detailed study, because these contents were too much complicated and manifold, and sufficient suitable data and time were not given for calcualtion.

The group unit costs in the Proposal of IBRD Power 15 are estimated by considering actual results of past projects and the latest market price. These costs are seemed very suitable to the estimation, so they are applied as the group unit costs of this estimation after some modification. Table 3.1-14 shows the group unit costs and Table 3.1-15 shows its break down. These costs are based on IBRD project costs as metnioned above, and the modification is to add the communication fee to the line bay cost, taking into account the increase of telegraphic information in future.

Construction cost of each substation is estimated by summing up the group unit costs. As to the machinery of 150 kV communication and transformers for electric power, construction cost includes the dispatching fee of the Supplier's expert for erection at the site. Therefore, this dispatching fee is added to the construction cost. Man-months required for each substation are about from two to six, and man-month rate is estimated at $17,000.- at foreign currency portion and at Rp.1,700,000.- at local currency portion.

(b) Unit prices of main machines

The estimated CIF prices of tools & machinery for substation were compared with those of other projects.

The main comparison is shown in Table 3.1-16, Fig. 3.1-6. The prices adopted herein are lower ones than actual, in consideration of recent tendency of decreasing world price.

However, only the prices of transformers for electric power are estimated higher at this stage, because Indonesia has the intention to manufacture these transformers in this country, and higher prices are necessary to maintain the local manufacturers.

(c) Comparison between sum of estimated construction unit prices and that of other projects

Table 3.1-17 shows the comparison between construction costs of standard new substation for electric power distribution based on group unit costs and those costs of other projects. Estimated costs herein are almost equivalent to those of EJP 3rd Project and Surabaya Project. They are, however, higher than the costs of acceleration project and lower than those of Gresick Project.

(4) Construction unit cost of electric power distribution lines

(a) Estimate method and Group Unit Costs

Foreign currency portion of construction cost of electric power distribution lines consists of a part of foreign and local purchase cost of machinery and construction materials, while local currency portion consists of local purchase cost of construction materials, foundation works cost, transportation and installation cost and so on. Group unit costs were prepared by classifying organization of electric power distribution lines into parts. It is very difficult to compute the group unit costs with concrete and detailed study, because these contents were too much complicated and manifold, the division rate of purchase cost of machinery and some materials into foreign and local currency portions was different in every project, and sufficient suitable data and time were not given for calculation.

The group unit costs in the Proposal of IBRD Power 14 are estimated by considering actual results of past projects and the latest Market price. These costs are seemed very suitable to the estimation, so they are applied as the group unit costs of this estimation after some modification. Table 3.1-18 shows the group unit costs, which are, however, different from those costs of IBRD Projects in the following points.

i) Group unit cost of LV line is equivalent to the unit costs of new lines and additional lines. But even if the unit costs of new lines and additional lines are same, each group unit costs is not the same one, because each Project has different organization ratio of new and additional lines.

Group unit costs of new lines and additional lines are tabulated as below:

Item		Unit	Group Unit Cost	
			FC (US$)	LC (Rp x 10^6)
LV line	New	Km	5,415	1.91
LV line	Add	Km	4,320	1.18

ii) The unit cost of Service Equipment is equivalent to each consumer's standard cost in the residence, commercial and industrial areas. Each group unit cost is not the same one, because of the difference of consumer's organization ratio in each area, as mentioned above.

Each unit cost is as follows.

Consumer	Group Unit Cost (Rp)	
	Foreign	Local
Residential (L.V. 1ϕ)	17,000	17,000
Commercial (L.V. 3ϕ)	72,000	21,000
Industrial (M.V.)	20,330,000	1,702,000

Foreign currency portion covers a part of local purchase cost of machinery and construction materials, it is because some ratio of foreign currency is charged to these machinery and construction materials to be manufactured, assembled, processed and so on in Indonesia. (See Table 3.1-19)

(b) Comparison between estimated group unit costs and those of other projects

Table 3.1-20 shows the comparison between estimated group unit costs and those other projects. Judging from the total amount of foreign currency portion and local currency portion, the estimated group unit costs in this stage are generally lower than those of EJP 3rd Stage project, SDP project and Five Cities project. Especially, as to transformers for electric power distribution, lower unit cost is adopted considering the recent tendency of decreasing world price.

3.1.2. Construction Quantity and Cost Estimate

(1) Construction Quantity

(a) Transmission line facilities

Construction quantity in each item of transmission line which is planned as short-term program is shown in Table - 3.1-21. Construction quantity after 1983 in shown in Fig. 3.1-8. This Figure reveals that in comparison with an ordinary year 150kV T/L construction occupies a considerable per-centage in 1987, but to the contrary, related 70kV T/L construction commands majority in 1988. Also, from a viewpoint of loss reduction and load increment tendency in the future, 150kV T/L in Madura Island is scheduled to be adopted with 330mm^2 ACSR standard conductor.

(b) Substation facilities

i) Expansion of T/L bay

Expansion of T/L bay is needed with new installation of transmission line. The construction quantity of such expansion is also shown in Table 3.1-1.

ii) Power transformer

The construction quantity of primary transformer and distribution transformer, both listed in short-term program is shown in Table 3.1-2 and Table 3.1-3. Construction quantity and related projects after 1983 are represented in Fig. 3.1-2. It is found in this Figure that the new and additional installation of transformers has remarkably increased in 1987. The Construction quantity of primary transformers and distribution transformers in 1988 indicates almost average one.

(c) Distribution Facilities

The construction quantity of distribution facilities by each service area, planned in short-term program, is shown in Table 3.1-24. And, both of construction quantity and name of related projects after 1984 are shown in Fig. 3.1-10. Affected by the concentrating and rushing works in 1984 and 1985, the construction quantity was decreased in 1986 and 1987. But in 1988, due to the increasing number of consumers the quantity is turning to almost same as normal years.

(2) Cost Estimate (Direct construction cost)

(a) Transmission line facilities

Route length of transmission line is clear, so the calculation of this length multiplied by unit cost of construction makes direct construction cost. In case of route length between 10KM and 30KM, unit costs at 10KM or 30KM length, whichever closer from the intermediate point of 19KM, are applied to the cost estimate of T/L facilities in usual area, (See Fig. 3.1-11). The applicable ratio in the category by the kind of soil in local currency portion is to be estimated from the number of tower foundation type. By doing application method as mentioned above, the direct construction cost of each T/L in foreign and local currency portions are computed. The results are shown in Table 3.1-25 and Table 3.1-26.

(b) Substation facilities

Direct construction cost of each substation is estimated from group unit cost shown in Table 3.1-14. The Result of calculations is shown in Table 3.1-27 and Table 3.1-28.

(c) Distribution Facilities

Direct construction cost is estimated by the group unit cost shown in Table 3.1-28 and the construction quantity in Table 3.1-24. Result is shown in Table 3.1-29.

(3) Cost Estimate (others)

(a) Engineering Fee

Engineering fee in 1987 is estimated from the whole projected costs in that year. Namely, Engineering fee in foreign currency portion is 6.8% of total direct construction cost, and that in local currency portion is 24.6% of the Engineering fee in foreign currency portion. Engineering fee in 1988 is also computed with an appropriate ratio of Engineering fee/total direct construction cost, fixed in consideration of project work volume in 1988. Calculation results are shown in Table 2.4-30.

(b) Physical Contingency

At the stage of Feasibility study, 10% of total direct construction cost both in F.C & L.C portions is considered as physical contingency, as usual.

(c) Price Escalation & Exchange Rate

Price escalation is set at 5% per year for F.C portion, and 12% per year for L.C portion.
Exchange rate is set as below:

1 US$ = 992Rp. = 235¥

1 Rp. = 0.237¥

(d) Estimation of total construction cost & annual disbursement amount.

Total construction cost is composed of total direct cost with physical contingency and Engineering fee with Price escalation, both of which are allocated for annual disbursement. Table 3.1-3 shows the total construction cost and annual disbursement calculated in short term program in 1987 and 1988. Disbursement Schedule of direct cost and Engineering fee are shown in Table 3.1-32

3.1.3. Implementation Schedule

Supposing Feasibility study will be finished in July 1984 and construction completed within Scheduled year, the Implementation schedule was prepared as shown in Table 3.1-33. This Schedule indicated that construction period is short and schedule is tight in every stage in 1987. Therefore, if loan arrangement and PLN internal procedure are not going smoothly, the Project will face to difficulty in keeping the successful completion schedule of construction especially for E/S stage. Considering the above, the recommendable commencement is to start the work immediately after Loan Agreement. Also in 1988, all preparatory works are required to start as soon as possible.

Table 3.1-1 Unit price of main equipment

Item	Particulars	C.I.F. Unit price (US$)		
		*A.P.	**S.D.P.	Estimated
Tower	Tower material (/Ton)	889	920	900
Conductor	A.C.S.R/AW 330mm^2 (/KM)	2,629	2,658	2,700
	A.C.S.R "Ostrich" 300MCM (/KM)	1,245	1,150	1,200
Earth Wire	A.W. 55mm^2 (/KM)	957	859	900
	G.S.W 55mm^2 (/KM)	464	$241 \times \frac{55}{38} = 349$	370
Insulator	(/Stringing)			
°150KV ACSR/AW 330mm^2 Twin 11 units Including Arcing Horn	Single suspension string	238	271	280
	Double suspension string	420	473	480
	Double tension string	604	689	690
°150KV ACSR/AW 330mm^2 11 units Including A.H.	Single suspension string	200	233	240
	Double suspension string	363		440
	Single tension string	270	300	300
	Double tension string	445	503	500
°70KV ACSR 300MCM 7 units Including A.H.	Single suspension string	109	98	100
	Double suspension string	238	255	260
	Single tension string	169	113	120
	Double tension string	303	252	260

NOTE:

* A.P. Based on T/L Acceleration Project for East Java

** S.D.P Based on Surabaya City Power Distribution Project

Table 3.1-2 Price ratio of accessory to main equipment

Item	Accessory Ratio (%)			Accessory
	*PLN	E.J. 3rd	Estimated	
Tower	(2.6)	3	3	Earth angle, Number plate, Template
Conductor				Joint sleeve, Repair sleeve, Parallel groove clamp, Damper, Armour rod. (Twin only - Line spacer, Jumper spacer)
150KV 330mm² Twin		20	20	
150KV 330mm²	((8.9))	15	15	
70KV 300MCM		25	25	
Insulator				Jumper support insulator
150KV 330mm² Twin Sup.		-	-	
" Ten.		8	8	
150KV 330mm² Sup.		-	-	
" Ten.	8.75	8	8	
70KV 300MCM Sup.		-	-	
" Ten.		16	16	
Ground Wire				Joint sleeve, Parallel groove clamp, Damper, Suspension acs., Tension acs., Jumper clamp.
A.W. 55mm²	40.3	40	40	
G.S.W 55mm²		120	120	

*P.L.N Based on Yugoslavia, Belgium, France, Tepsco, data.

( ) exclude Name plate

(( )) exclude Armour rod

Table 3.1-3 Total Amount of Transmission Line Foreign Cost

(150KV 330mm² Twin Line. km)

A: Field and Hill 10KM
B: Field and Hill 30KM
C: Residential area 10KM

a) Double Circuit Item	US$/KM	
° Tower, suspension and angle type with accessories	A. 23,824 B. 21,785 C. 26,141	$25.7^{Ton/KM} \times 900^{\$/Ton} \times 1.03 = 23.824$ 23.5 " " = 21.785 28.2 " " = 26.141
° Conductor ACSR with fittings	40,046	$2{,}700^{\$/KM} \times 2^{Twin} \times 3^{Phase} \times 1.03 \times 2^{c.c.t} \times 1.20 = 40{,}046$
° Earth wire, AW with fittings	2,596	$900^{\$/KM} \times 1.03 \times 2 \times 1.40 = 2{,}596$
° Insulator, ball and Socket type string with fittings	A. 12,404 B. 10,670 C. 12,627	Cost/Tower: Single sup. string: $280^{\$/string} \times 6 = 1{,}680$ Double ": $480 \times 6 = 2{,}880$ Double tens. string: $690 \times 12 \times 1.08 = 8{,}942$ A. $(1{,}680^{Single} \times \frac{3}{4} + 2{,}880^{double} \times \frac{1}{4}) \times 2.232$ = 4,420-Sup. 8,942 x 0.893 = 7,984-Ten. B. $(1{,}680 \times \frac{3}{4} + 2{,}880 \times \frac{1}{4}) \times 2.372$ = 4,696 8,942 x 0.668 = 5,974 C. $(1{,}680 \times \frac{2}{3} + 2{,}880 \times \frac{1}{3}) \times 2.232$ = 4,643 8,942 x 0.893 = 7,984
Total	A. 78,870 B. 75,097 C. 81,410	

Table 3.1-4 Breakdown of T/L Unit Price (F.C.)—— 150KV 330mm^2 Twin, km.

(US$/KM) As of April 1984

	Item	Estimated			Gresik Project
		A	B	C	
a) Double Circuit	Tower with accessories	23,824	21,785	26,141	37,826
	Conductor with fittings	40,046	40,046	40,046	57,895
	Earth wire "	2,596	2,596	2,596	6,989
	Insulator "	12,404	10,670	12,627	25,204
	Others	12,383	11,790	12,781	——
	Total	91,253	86,887	94,191	127,914
b) Single Circuit on double circuit towers	Tower	23,824	21,785	26,141	37,826
	Conductor	20,023	20,023	20,023	28,947
	Earth wire	1,298	1,298	1,298	3,494
	Insulator	6,202	5,335	6,314	12,602
	Others	8,061	7,605	8,443	——
	Total	59,408	56,046	62,219	82,869
c) Additional second circuit	Conductor	20,023	20,023	20,023	28,947
	Earth wire	1,298	1,298	1,298	3,494
	Insulator	6,202	5,335	6,314	12,602
	Others	4,321	4,185	4,339	——
	Total	31,844	30,841	31,974	45,043

NOTE

A: Field and Hill Route Length 10KM

B: Field and Hill Route Length 30KM

C: Residential Area Route Length 10KM

Table 3.1-5 Breakdown of T/L Unit Price (F.C.) —— 150KV $330mm^2$. km.

(US$/KM) As of April 1984

	Item	JICA			IBRD	Acceleration	E.J. 3rd
		A	B	C	(1986/87)		(1979)
a) Double circuit	Tower with accessories	16,408	15,296	18,911	28,090	20,581	
	Conductor with fittings	19,189	19,189	19,189	31,011	18,388	
	Earth wire "	2,596	2,596	2,596	3,371	2,341	
	Insulator "	7,929	7,290	8,345	10,562	5,070	
	Others	7,241	6,966	7,699	——	——	
	Total	53,363	51,337	56,740	73,034	46,380	
b) Single circuit on double circuit towers	Tower	16,408	15,296	18,911	28,090	20,581	10,931
	Conductor	9,595	9,595	9,595	15,506	8,898	7,392
	Earth wire	1,298	1,298	1,298	1,685	1,523	1,085
	Insulator	3,965	3,645	4,173	5,281	2,925	3,100
	Others	4,909	4,684	5,334	——	——	——
	Total	36,175	34,518	39,311	50,562	33,927	22,508 (28,416)
c) Additional second circuit	Conductor	9,595	9,595	9,595	15,506	10,852	
	Earth wire	1,298	1,298	1,298	1,685	1,523	
	Insulator	3,965	3,645	4,173	5,281	3,666	
	Others	2,333	2,282	2,365	——	——	
	Total	17,191	16,820	17,431	22,472	16,041	

( ) Escal: 1.06^4

NOTE

A: Field and Hill Route Length 10KM

B: Field and Hill Route Length 30KM

C: Residential Area Route Length 10KM

Table 3.1-6 Breakdown of T/L Unit Price (F.C.) —— 70KV 300MCM. km.

(US$/KM) As of April 1984

	Item	JICA			IBRD	Acceleration	E.J. 3rd
		A	B	C	(1986/87)		(1979)
a) Double circuit	Tower with accessories	9,455	8,387	11,532	16,854	14,822	
	Conductor with fittings	9,270	9,270	9,270	13,989	12,624	
	Earth wire "	1,677	1,677	1,677	1,517	3,614	
	Insulator "	3,802	3,434	4,125	6,966	9,982	
	Others	3,800	3,575	4,177	——	——	
	Total	28,004	26,343	30,781	39,326	41,042	
b) Single circuit on double circuit towers	Tower	9,455	8,387	11,532	16,854		6,684
	Conductor	4,635	4,635	4,635	6,994		3,242
	Earth wire	839	839	839	759		735
	Insulator	1,901	1,717	2,063	3,483		1,903
	Others	2,642	2,446	2,994	——		——
	Total	19,472	18,024	22,063	28,090		12,565 (15,863)
c) Additional second circuit	Conductor	4,635	4,635	4,635	6,994		
	Earth wire	839	839	839	759		
	Insulator	1,901	1,717	2,063	3,483		
	Others	1,158	1,129	1,183	——		
	Total	8,533	8,320	8,720	11,236		
d) Rehabilitation	$50mm^2$ HDCC → 300MCM ACSR c) x 2	17,066	16,640	17,440	44,949		

A: Field and Hill Route Length 10KM
B: " " 30KM
C: Residential Area " 10KM

( ) Escal: 1.06^4

Table 3.1-7 Tower Foundation and Erection Cost (km)

(IN Rpx10^3) As of Apr. 1984

Item \ Area			X	Y	Z
Unit cost per Ton	Foundation Erection Total		475 126 601	741 126 867	2,376 126 2,502
150KV 330mm^2 ACSR Twin	A B C	25,7 Ton/KM 23,5 " 28,2 "	15,446 14,124 16,948	22,282 20,375 24,449	64,301 58,797 70,556
150KV 330mm^2 ACSR	A B C	17,7 " 16,5 " 20,4 "	10,637 9,916 12,260	15,340 14,300 17,679	44,291 40,990 51,049
70KV 300MCM	A B C	10,20 " 9,48 " 12,44	6,130 5,697 7,476	8,843 8,219 10,785	25,520 23,719 31,125

X: Hill and Farm (Foundation Type L.M.)

Y: Paddy Field (Foundation Type H.)

Z: Pile Foundation (Foundation Type Cakar Ayam)

Table 3.1-8 Stringing Cost (km)

(IN Rpx10^3/KM) As of Apr. 1984

No. of cct	2 c.c.t	1 c.c.t
150KV 330mm^2 ACSR Twin	5,146	4,488
150KV 330mm^2 ACSR	4,117	3,590
70KV 300MCM ACSR	2,535	2,209
70KV 300MCM Rehabilitation	4,310	——

Table 3.1-9 Land Purchase (km)

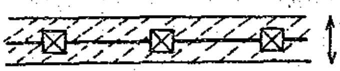
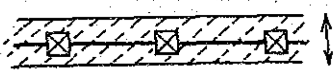
As of Apr. 1984

Item / Voltage	Area		Cost ($Rpx10^3/KM$)	
			Surabaya (*6,777 Rp/m^2)	Others (*4,516 Rp/m^2)
150KV	12m × 12m  $12x12=144(m^2/TW)$	A.C. 144x3.125 $=450(m^2/KM)$ B. 144x3.04 $=437.8(m^2/KM)$	A.C. 3,050 B. 2,967	A.C. 2,034 B. 1,978
70KV	8∿10m × 8∿10m  $10x10=100(m^2/TW)$	A.C. 100x3.125 $=312.5(m^2/KM)$ B. 100x3.04 $=304(m^2/KM)$	A.C. 2,118 B. 2,060	A.C. 1,411 B. 1,373

Note:* Unit Price of land purchase bases on unit price in 1980 (Surabaya 3,000Rp/m^2, Others 2,000Rp/m^2).

Table 3.1-10 Cost of Right of Way (km)

As of Apr. 1984

Item / Voltage	Area	Cost ($Rpx10^3/KM$)	
		Surabaya (*903 Rp/m^2)	Others (*790 Rp/m^2)
150KV	 16m $16x1,000x0.9 = 14.4x10^3(m^2/KM)$	13,010	11,377
70KV	 12m $12x1,000x0.9 = 10.8x10^3(m^2/KM)$	9,752	8,532

Note:* Unit Price of Right of way bases on unit price in 1980 (Surabaya 400Rp/m^2, Others 350Rp/m^2).

Table 3.1-11 Total Amount of Land Purchase and Right of Way (km)

As of Apr. 1984

Voltage		Total ($Rpx10^3/Km$) Surabaya	Others
150KV	A.C	16,060	13,411
	B	15,977	13,355
70KV	A.C	11,870	9,943
	B	11,812	9,905

Table 3.1-12 Administration Cost of PLN (km)

(IN $Rpx10^3/Km$) As of Apr. 1984

	2/2, 1/2	2nd	Rehabilitation
150KV Twin	354	177	—
150KV	283	141	—
70KV	174	87	240

Table 3.1-13 Local Currency Cost of T/L

As of Apr. 1984
(IN Rpx10^3/KM)

. <u>150KV Twin</u> 2/2 cct. Km

	A					B					C				
	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T
X	15,446	5,146	13,411	354	34,357	14,124	5,146	13,355	354	32,979	16,948	5,146	13,411	354	35,859
Y	22,282	"	"	"	41,193	20,375	"	"	"	39,230	24,449	"	"	"	43,360
Z	64,301	"	"	"	83,212	58,797	"	"	"	77,652	70,556	"	"	"	89,467

1/2 cct. Km

	A					B					C				
	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T
X	15,446	4,488	13,411	354	33,699	14,124	4,488	13,355	354	32,321	16,948	4,488	13,411	354	35,201
Y	22,282	"	"	"	40,535	20,375	"	"	"	38,572	24,449	"	"	"	42,702
Z	64,301	"	"	"	82,554	58,797	"	"	"	76,994	70,556	"	"	"	88,809

2nd cct. Km

	A					B					C				
	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T
X,Y,Z	-	4,488	-	177	4,665	-	4,488	-	177	4,665	-	4,488	-	177	4,665

. <u>150KV</u> 2/2 cct. Km (I.B.R.D.14-75,690, A.P-11,880)

	A					B					C				
	Tw	St.	L.R.	A.C.	T.	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T
X	10,637	4,117	13,411	283	28,448	9,916	4,117	13,355	283	27,671	12,260	4,117	13,411	283	30,071
Y	15,340	"	"	"	33,150	14,300	"	"	"	32,055	17,679	"	"	"	35,490
Z	40,291	"	"	"	62,104	40,990	"	"	"	59,045	51,049	"	"	"	68,860

. <u>150KV</u> 1/2 cct. Km (I.B.R.D.14-52,390, A.P.10,390)

	A					B					C				
	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T
X	10,637	3,590	13,411	283	27,921	9,916	3,590	13,355	283	27,144	12,260	3,590	13,411	283	29,544
Y	15,340	"	"	"	32,623	14,300	"	"	"	31,528	17,679	"	"	"	34,962
Z	40,201	"	"	"	61,577	40,990	"	"	"	58,518	51,049	"	"	"	68,333

. <u>150KV</u> 2nd cct. Km (I.B.R.D.14-23,290, A.P.4,960)

	A					B					C				
	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T
X,Y,Z	-	3,590	-	141	3,731	-	3,590	-	141	3,731	-	3,590	-	141	3,731

<u>70KV</u> 2/2 Km (I.B.R.D.14-40,800, A.P-18,010) Rpx10^3

	A					B					C				
	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T
X	6,130	2,535	9,943	174	18,782	5,697	2,535	9,905	174	18,311	7,476	2,535	9,943	174	20,128
Y	8,843	"	"	"	21,495	8,219	"	"	"	20,833	10,785	"	"	"	23,437
Z	25,520	"	"	"	38,172	23,719	"	"	"	36,333	31,125	"	"	"	43,777

1/2 cct. Km (I.B.R.D.14-29.12)

	A					B					C				
	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T
X	6,130	2,209	9,943	174	18,456	5,697	2,209	9,905	174	17,985	7,476	2,209	9,943	174	19,802
Y	8,843	"	"	"	21,169	8,219	"	"	"	20,507	10,785	"	"	"	23,111
Z	25,520	"	"	"	37,846	23,719	"	"	"	36,007	31,125	"	"	"	43,451

2nd cct. Km (I.B.R.D.14-11.64)

	A					B					C				
	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T
X,Y,Z	-	2,209	-	87	2,296	-	2,209	-	87	2,296	-	2,209	-	87	2,296

Rehabilitation (2 cct.) (I.B.R.D.14-46,590)

	A					B					C				
	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T	Tw	St.	L.R.	A.C.	T
X,Y,Z	-	4,310	-	240	4,550	-	4,310	-	240	4,550	-	4,310	-	240	4,550

X : Hill and Farm
Z : Cakar Ayam
St: Cost of Stringing
A.C.: Administration Cost of P.L.N.
Y : Paddy Field
Tw: Cost of Foundation and Erection
L.R.: Land Purchase and Right of way (Surabaya: x1.2)
T : Total

Table 3.1-14 Group Unit Cost

As of Apr. 1984

		F.C. ($US)	L.C. (Rp.x10^6)
150/70KV Transformer	kVA	13.483	.00116
150/20KV Transformer	kVA	14.607	.00116
70/20KV Transformer	kVA	13.483	.00116
150KV Line 1st bay	bay	339,102	148.00
150KV Line 2nd bay	bay	279,102	138.00
150KV Bus coupler	bay	167,416	128.08
150KV Transformer bay	bay	280,900	128.08
70KV Line 1st bay	bay	189,800	104.79
70KV Line 2nd bay	bay	160,600	104.79
70KV Bus coupler	bay	122,472	104.79
70KV Transformer bay	bay	168,540	104.79
New Substation building			523.79
20KV Switchgear	unit	16,854	5.83

Table 3.1-15 Breakdown of Group Unit Cost (sheet 1/2)

As of Apr. 1984

a) 150 kV Line Feeder Bay

Item	Quantity	Cost (US$) 1st bay	Cost (US$) 2nd bay
Circuit Breaker	1	39,326	39,326
Busbar Isolator	2	22,472	22,472
Line Isolator	1	11,236	11,236
Current Transformer	3	13,483	13,483
V.T.	1	11,236	11,236
C.C.P.D.	2	39,326	39,326
Surge Diverter	3	8,989	8,989
Control & Relay Panels	1 Lot	44,944	44,944
Busbar Structures, etc	1 Lot	28,090	28,090
Supervisory/Protection	1 Lot	120,000	60,000
		339,102	279,102

b) 150 kV Bus Coupler Bay

Item	Quantity	Cost (US$)
Circuit Breaker	1	39,326
Busbar Isolator	2	22,472
Current Transformer	6	26,966
Control & Relay Panels	1 Lot	44,944
Busbar Structures, etc	1 Lot	33,708
		167,416

c) 150 kV Transformer Bay

Circuit Breaker	1	39,326
Busbar Isolator	2	22,472
Current Transformer	3	13,483
Surge Diverter	3	8,989
Control & Relay Panels	1 Lot	50,562
Tap Change control panel	1 Lot	73,034
V,T (busbar-mounted)	3	33,708
Busbars, Structures, etc.	1 Lot	39,326
		280,900

Table 3.1-15 Breakdown of Group Unit Cost (sheet 2/2)

d) 70 kV Line Feeder Bay

Item	Quantity	Cost (US$) 1st bay	Cost (US$) 2nd bay
Circuit Breaker	1	20,225	20,225
Busbar Isolator	2	15,730	15,730
Line Isolator	1	7,865	7,865
Current Transformer	3	6,742	6,742
C.C.P.D.	2	20,225	20,225
V.T.	1	2,247	2,247
Surge Diverter	3	3,371	3,371
Control & Relay Panels	1 Lot	33,708	33,708
Busbar, Structures etc	1 Lot	13,483	13,483
Supervisory/protection	1 Lot	66,204	37,004
		189,800	160,600

e) 70 kV Bus Coupler Bay

Item	Quantity	Cost (US$)
Circuit Breaker	1	20,225
Busbar Isolator	2	15,730
Current Transformer	6	13,483
Control & Relay Panels	1 Lot	44,944
Busbars, Structures, etc	1 Lot	28,090
		122,472

f) 70 kV Transformer Bay

Item	Quantity	Cost (US$)
Circuit Breaker	1	20,225
Busbar Isolator	2	15,730
Current Transformer	3	6,742
Control & Relay Panels	1 Lot	30,326
Busbars, Structures, etc	1 Lot	28,090
Tap Change Control Panel	1 Lot	17,191
Grounding Resistors	1 Lot	11,236
		129,540

Table 3.1-16 150kV Schedule of Unit Price

As of Apr. 1984
(IN US$)

Item \ Project	J.I.C.A. Estimate	I.B.R.D. (1986/87)	Gresik P/s (1986/87, 1987/88)	Acceleration (1983/84)	S.D.P. (1984/85)	E.J.P.3rd (1979/80)
1. Circuit Breaker 2,000A or 1,250A 1p.c.	39,326	39,326	98,104	51,178	69,440	85,196
2. Isolater (3ϕ 1Set) 2,000A,R	11,236	11,236	16,897	14,220	13,110	15,677
3. Current Transformer (3ϕ 1Set) 1,600 , 800/5A	13,483	13,483		11,486	29,471	11,528
4. Capacity Vtg Transfrmer For Bus. , 1,oooVA (3ϕ 1Set)	33,708	33,708	98,570	18,650	41,084	48,691
5. Arrester(3ϕ 1Set) 10KA	8,989	8,989	14,136	7,576	9,034	11,082

Table 3.1-17 Comparison Table Cf New S/S Construction Cost (F.C.)

(IN US$ Million) (Excluding Guidance fee)

S/S \ Project	Estimate	I.B.R.D (1986/87)	Gresik P/SIII,IV (1986/87,1987/88)	Acceleration (1983/84)	Surabaya Proj. (F/S 1981/82)	E.J.P. 3rd (1979/80)	Remark
(1) BABATAN S/S							
2x150kV line bays	0.618	0.494	0.924		0.999		
1x150kV trans. bay	0.281	0.281	0.388		0.308		
1x50MVA 150/20kV Tr.	0.730	0.730	0.744		0.501		
1x150kV bus coupler	0.167	0.167	0.200		0.205		
10unit 20kV Switchgear	0.168	0.168	0.168		0.340		
Total	1.964	1.840	2.424		2.353 *(1.977)		*Estimate of contract Price 2.353×0.84=1.977
(2) KRAKSAAN S/S							
4x150kV line bays	1.236	0.988	1.848	0.964			
1x150kV trans. bay	0.281	0.281	0.388	0.178			
1x20MVA 150/20kV Tr.	0.292	0.292	0.298	0.206			
1x150kV bus coupler.	0.167	0.167	0.200	0.132			
4unit 20kV Switchgear	0.068	0.068	0.068	0.068			
Total	2.044	1.796	2.802	1.548		1.967	
(3) PAMEKASAN S/S							
2x150kV line bay	0.618	0.494	0.924	0.482			
1x150kV trans. bay	0.281	0.281	0.388	0.178			
1x10MVA 150/20kV Tr.	0.146	0.146	0.149	0.125			
3unit 20kV Switchgear	0.051	0.051	0.051	0.051			
Total	1.096	0.972	1.512	1.836			

Table 3.1-18 Group Unit Cost

As of Apr 1984

Item		Unit	F.C.(US$)	L.C.($Rp \times 10^6$)
20kV Line		Km	9,405	4.31
L.V. Line		Km	5,181	1.52
Transf. 160KVA 3ϕ or 50KVA 1$\phi \times 3$		Unit	1,613	0.075
Service Equipment	L.V.(1ϕ)	PC	17	0.017
	L.V.(3ϕ)	PC	72	0.021
	M.V.	PC	20,330	1.702

Table 3.1-19 Indirect Foreign Cost
Based on Following Factors

(%)

Item	Foreign Cost	Local Cost
Concrete Poles	60	40
Wood Poles	0	100
Meters	85	15
Crossarm Material	45	55
All Other Materials	100	0
Labour	0	100

Table 3.1-20 Comparison Table of Unit Price for Project Cost

F.C. US$
L.C. Rp.
Total US$

ITEM / Name of Project		I.B.R.D. XV (1985/86,1986/87)	FIVE CITIES (A.D.B)	S. D. P. (A. D. B.)	E.J.P. III (O.E.C.F.)	Estimate
	F.C.	9,405	15,260.78	2,456.326	17,839.69	9,405
M.V. LINES (Km)	L.C.	4,310,000	3,723,827	9,355,012	3,723,627	4,310,000
TOTAL		13,762.94	19,026.02	11,915.39	21,604.93	13,763
	F.C.	4,977	5,398.52	182.124	5,339.62	5,181
L.V.. LINES (Km)	L.C.	1,618,000	1,500,000	5,093,277	1,465,000	1,520,000
TOTAL		6,613.0	6,915.2	5,332.05	6,820.9	6,718
(50 KVA x 3 units)	F.C.	1,612.44	2,408.93	3,640.593	7,130.22	1,613
Distribution Transformer	L.C.	75,000	419,000	330,455	190,000	75,000
TOTAL		1,688.27	2,832.60	3,974.72	7,524.56	1,689
	F.C.	58.43	81.86		95.27	44.40
Service Equipment (P.C.S.)	L.C.	17,050.0	23,000		23,000	17,150
TOTAL		75.67	105.12		118.53	61,741

Table 3.1-21 Transmission Line Projects in Short Term Program

Year	No.	From	To	Type				Feeder Bay	
				Voltage (KV)	c.c.t	Conductor size	route length (km)	from	to
1987	1	Sukolilo	Kenjeran	150	2 nd	330 mm²	4.5	1	1
〃	2	Krian	Babatan	150	2	330 mm²	11.6	2	2
〃	3	Waru	Sawahan	70	2 (Re)	300MCM	10.6	—	—
〃	4	Probolinggo	Kraksaan	150	2	330 mm²	31.5	2	2
〃	5	Kraksaan	Paiton	150	2	330 mm²	19.7	2	2
〃	6	Ngawi	Incomer	150	2	240 mm²	5.0	2	0
〃	7	Babat	Tuban	150	1 st	330 mm²	30.9	1	1
〃	8	Gili Timur	Bangkalan	150	1 st	330 mm²	144.3	1	1
		Bangkalan	Sampang					1	1
		Sampang	Pamekasan					1	1
		Pamekasan	Sumenep					1	1
〃	9	Turen	Incomer	70	2 nd	300MCM	10.5	1	0
1988	10	Tolungagung	New Kediri	70	2 nd	300MCM	29.3	1	1
〃	11	Karangkates	Sengguruh	70	2 nd	300MCM	26.9	1	1
				70	1 (Re)	300MCM	43.8	—	—
〃	12	New Madium	Magetan	70	2	300MCM	35.0	2	2
〃	13	Mojokerto	Kertosono	70	2 nd	300MCM	114.5	1	1
		Kertosono	New Madium					1	1
Total			Transmission Line	150	2	330 mm²	67.8		
				150	1 st	330 mm²	180.8		
				150	2 nd	330 mm²	4.5		
				70	2	300MCM	35.0		
				70	2 nd	300MCM	181.2		
				70	2 (Re)	300MCM	10.6		
					1 (Re)	300MCM	43.8		
			Feeder Bay	150KV				28	
				70KV				13	

Table 3.1-22 Connecting Transformer

Year	No.	Substation	Voltafe(kV)	Capacity(MVA)	Mar. 1988 Load (MW)	Capacity (MVA) Before Plan	After Plan
1987		Connecting Substation					
	1	Segoromadu	150/70	2 x 50	61.4	50	150
	2	Mojokerto	150/70	1 x 50	29.3	50	100
	3	New Kediri	150/70	1 x 50	33.9	35	85
		Sub Total	150/70	200			

Table 3.1-23 Distribution Transformer

Year	No.	Substation	Voltage (kV)	Capacity (MVA)	Remark
1987		Connecting Substation			
"	1	Segoromadu	150/20	1 x 30	
"	2	Mojokerto	150/20	2 x 30	
1987		Distribution Substation			
"	3	Rungkut	150/20	1 x 50	
"	4	Babatan	150/20	1 x 50	N
"	5	Probolingo	150/20	1 x 20	
"	6	Kraksaan	150/20	1 x 20	N
"	7	Tuban	150/20	1 x 20	N
"	8	Ngawi	150/20	1 x 10	N
"	9	Paiton	150/20	1 x 20	N
"	10	Bangkalan	150/20	1 x 10	N
"	11	Sampang	150/20	1 x 10	N
"	12	Pamekasan	150/20	1 x 10	N
"	13	Sumenep	150/20	1 x 10	N
"	14	Mobile Transformer	150(70)/20	1 x 30	
"	15	New Madium	150/20	1 x 20	
1988	16	Sukolilo	150/20	1 x 50	
"	17	Banyuwangi	150/20	1 x 20	
"	18	Petrokimia	150/20	1 x 30	
"	19	Ujung	70/20	1 x 30	
"	20	Waru	150/20	1 x 50	
"	21	Kertosono	70/20	1 x 10	
"	22	Tulungagung	70/20	1 x 20	
"	23	Jember	150/20	1 x 20	
"	24	New Kediri	150/20	1 x 30	
"	25	Magetan	70/20	1 x 20	
Total			150/20 70/20	570 80	

Note. N ; New construction S/S

Table 3.1-24 Distribution Line Projects in short term Program

Year	No.	Area	M.V. (km.s)	Dist.Tr. (unit)	L.V. (km.s)	Service Eq. (P.C.S.)	Sectin.Sw. (P.C.S.)
1987	1	Pamekasan	91	169	253.5		
"	2	Kediri	24	163	244.5		
		Sub total	115	332	498	99,385	16
1988	3	North Surabaya	40	340	478.5		
"	4	South Surabaya	47.5	400	1,080		
"	5	Malang	54	51	76.5		
"	6	Pamekasan	108	44	66.53		
"	7	Situbondo	53	27	41.29		
"	8	Madium	60	68	103.38		
"	9	Jember	45	23	330.02		
"	10	Kediri	25	11	165		
"	11	Mojokerto	30	10	14.6		
"	12	Banyuwangi	27	20	29.6		
		Sub total	489.5	994	1,939.92	298,200	68
Total			604.5	1,326	2,437.92	397,585	84

Table 3.1-25 Direct cost of T/L

As of April 1984

Foreign Currency Potion

1987/88

No.	PROJECT	Route Length(KM)	Category	F.C unit Price(US$)	F.C. Costs(10^6\$)	F.C.+L.C. (10^6\$)
1	Sukolilo-Kenjeran	4.5	A	17,191	0.077	0.094
2	Krian-Babatan	11.6	C	56,740	0.658	1.166
3	Waru-Sawahan	10.6	A	17,066	0.181	0.229
4	Probolinggo-Kraksaan	31.5	B	51,337	1.617	2.712
5	Ngawi incomer	5	A	53,363	0.267	0.468
6	Kraksaan-Paiton	19.7	B	51,337	1.011	1.792
7	Babat-Tuban	30.9	B	34,518	1.067	2.514
8	Gili Timur-Sumenep	15.8	A	36,175	5.007	10.139
		128.5	B	34,518		
9	Turen Incomer	10.5	A	8,533	0.090	0.115
	Sub Total				9.975	19.229

1988/89

No.	PROJECT	Route Length(KM)	Category	F.C unit Price(US$)	F.C. Costs(10^6\$)	F.C.+L.C. (10^6\$)
10	Tulungagung-New Kediri	29.3	B	8,320	0.244	0.312
11	Karankates-Sengguruh	26.9	A	8,533	0.603	0.838
	(Re)	43.8	A	8,533		
12	New Madium-Magetan	35.0	B	26,343	0.922	1.739
13	Mojokerto-New Madium	114.5	B	8,320	0.953	1.218
	Sub Total				2.722	4.107

Table 3.1-26 Direct Costs of T/L

As of April 1984

Local Currency Portion

1987/88

No.	PROJECT	Route Length(KM)	Category(%)				L.C. unit Price(10^3Rp)	L.C. Cost(10^9Rp)	L.C. Cost (10^6\$)
				X	Y	Z			
1	Sukolilo-Kenjeran	4.5	A	-	-	-	3,731	0.017	0.017
2	Krian-Babatan	11.6	C	39.4	30.3	30.3	43,466	0.504	0.508
3	Waru-Sawahan	10.6	A	-	-	-	4,550	0.048	0.048
4	Probolinggo-Kraksaan	31.5	B	26.7	60.0	13.3	34,474	1.086	1.095
5	Nagwi-Incomer	5	A	38.7	32.3	29.0	39,726	0.199	0.201
6	Kraksaan-Paiton	19.7	B	18.9	51.1	30.0	39,324	0.775	0.781
7	Babat-Tuban	30.9	B	14.2	28.3	57.5	46,424	1.435	1.447
8	Gili Timur-Sumenep	15.8	A	29.2	52.7	18.1	36,490	5.091	5.132
		128.5	B	29.2	52.7	18.1	35,133		
9	Turen Incomer	10.5	A	-	-	-	2,296	0.025	0.025
Sub Total								9.180	9.254

1988/89

No.	PROJECT	Route Length(KM)	Category(%)				L.C. unit Price(10^3Rp)	L.C. Cost (10^9Rp)	L.C. Cost (10^6\$)
				X	Y	Z			
10	Talungagung-New Kadiri	29.3	B	-	-	-	2,296	0.067	0.068
11	Karangkates-Sengguruh	26.9	B	-	-	-	2,296	0.062	0.235
	(Re)	43.8	B	-	-	-	3,903	0.171	
12	New Madium-Magetan	35.0	B	0.3	0.5	0.2	23,177	0.811	0.817
13	Mojokerto-New Madium	114.5	B	-	-	-	2,296	0.263	0.265
Sub Total								1.374	1.385

Note 1US$=992Rp

Table 3.1-27 SUBSTATION PROJECT (1/5)

EAST JAVA (1987/88)

No. SUBSTATION	F C (US$ MILLION)	L C (RP x 10^9)	TOTAL (US$ MILLION)
1.SUKOLILO			
3x150kV line bays	0.897	0.384	
Guidance Fee	0.077	0.008	
	0.974	0.392	1.369
2.KENJERAN			
1x150kV line bay	0.279	0.128	
1x150kV bus coupler	0.167	0.128	
Guidance Fee	0.039	0.004	
	0.485	0.260	0.747
3.RUNGKUT			
1x150kV transf. bay	0.281	0.128	
1x50MVA, 150/20kV transformer	0.730	0.058	
10units, 20kV Switchgears	0.168	0.058	
Guidance Fee	0.039	0.004	
	1.218	0.248	1.468
4.KRIAN			
2x150kV line bays	0.618	0.256	
Guidance Fee	0.060	0.006	
	0.678	0.262	0.942
5.BABATAN/TROSOBO			
2x150kV line bays	0.618	0.256	
1x150kV transf. bay	0.281	0.128	
1x50MVA 150/20kV transformer	0.730	0.058	
1x150kV, bus coupler	0.167	0.128	
10units, 20kV Switchgears	0.168	0.058	
Substation building	-	0.524	
Guidance Fee	0.104	0.010	
	2.068	1.162	3.239

Table 3.1-27 SUBSTATION PROJECT (2/5)

EAST JAVA (1987/88)

No. SUBSTATION	F C (US$ MILLION)	L C (RP x 10^9)	TOTAL (US$ MILLION)
6.SEGOROMADU			
3x150kV transf. bays	0.843	0.384	
2x50MVA, 150/70kV transformers	1.348	0.116	
2x70kV, transf. bays	0.337	0.210	
1x30MVA,150/20kV transformer	0.438	0.035	
6units, 20kV Switchgears	0.102	0.035	
Guidance Fee	0.117	0.012	
	3.185	0.792	3.983
7.MOJOKERTO			
1x70kV transf. bay	0.169	0.105	
2x150kV transf. bays	0.562	0.256	
1x50MVA,150/70kV transf.	0.674	0.058	
2x30MVA,150/20kV transf.	0.876	0.069	
Guidance Fee	0.100	0.010	
	2.381	0.498	2.883
8.PROBOLINGGO			
2x150kV line bays	0.618	0.256	
1x150kV transf. bay	0.281	0.128	
1x20MVA,150/20kV transf.	0.292	0.023	
6unit, 20kV Switchgears	0.102	0.035	
Guidance Fee	0.090	0.009	
	1.383	0.451	1.838
9.KEDIRI			
1x150kV transf. bay	0.281	0.128	
1x50MVA,150/70kV transf.	0.674	0.058	
1x70kV transf. bay	0.169	0.105	
Guidance Fee	0.031	0.003	
	1.155	0.294	1.451

Table 3.1-27 SUBSTATION PROJECT (3/5)

EAST JAVA (1987/88)

No. SUBSTATION	F C (US$ MILLION)	L C (RP x 10^9)	TOTAL (US$ MILLION)
10.KRAKSAAN			
4x150kV line bays	1.236	0.512	
1x150kV transf. bay	0.281	0.128	
1x20MVA,150/20kV transf.	0.292	0.023	
1x150kV bus coupler	0.167	0.128	
4units, 20kV Switchgears	0.068	0.023	
Substation building	-	0.524	
Guidance Fee	0.130	0.013	
	2.174	1.351	3.536
11.BABAT			
1x150kV line bay	0.339	0.128	
Guidance Fee	0.026	0.003	
	0.365	0.131	0.497
12.TUBAN			
1x150kV line bay	0.339	0.128	
1x150kV transf. bay	0.281	0.128	
1x20MVA,150/20kV transf.	0.292	0.023	
4units,20kV Switchgears	0.068	0.023	
Substation building	-	0.524	
Guidance Fee	0.065	0.007	
	1.045	0.833	1.884
13.NGAWI			
2x150kV line bays	0.618	0.256	
1x150kV transf. bay	o.281	0.128	
1x10MVA,150/20kV transf.	0.146	0.012	
1x150kV bus coupler	0.167	0.128	
3units, 20kV Switchgears	0.051	0.017	
Substation building	-	0.524	
Guidance Fee	0.104	0.010	
	1.367	1.075	2.451

Table 3.1-27 SUBSTATION PROJECT (4/5)

EAST JAVA (1987/88)

No. SUBSTATION	F C (US$ MILLION)	L C (RP x 10^9)	TOTAL (US$ MILLION)
14.PAITON			
2x150kV line bays	0.618	0.256	
1x150kV bus coupler	0.167	0.128	
1x20MVA,150/20kV transf.	0.292	0.023	
1x150kV transfor. bay	0.281	0.128	
4units, 20kV Switchgears	0.068	0.023	
Guidance Fee	0.104	0.010	
	1.530	0.568	2.103
15.BANGKALAN			
2x150kV line bays	0.618	0.256	
1x150kV transf. bay	0.281	0.128	
1x10MVA,150/20kV transf.	0.146	0.012	
3units, 20kV Switchgears	0.051	0.017	
Substation building	-	0.524	
Guidance Fee	0.090	0.009	
	1.186	0.946	2.140
16.SAMPANG			
2x150kV line bays	0.618	0.256	
1x150kV transf. bay	0.281	0.128	
1x10MVA,150/20kV transf.	0.146	0.012	
3units, 20kV Switchgears	0.051	0.017	
Substation building	-	0.524	
Guidance Fee	0.090	0.009	
	1.186	0.946	2.140
17.PAMEKASAN			
2x150kV line bays	0.618	0.256	
1x150kV transf. bay	0.281	0.128	
1x10MVA,150/20kV transf	0.146	0.012	
3units, 20kV Switchgears	0.051	0.017	
Substation building	-	0.524	
Guidance Fee	0.090	0.009	
	1.186	0.946	2.140

Table 3.1-27 SUBSTATION PROJECT (5/5)

EAST JAVA (1987/88)

No. SUBSTATION	F C (US$ MILLION)	L C (RP x 10^9)	TOTAL (US$ MILLION)
18.SUMENEP			
1x150kV line bay	0.339	0.128	
1x150kV transf. bay	0.281	0.128	
1x10MVA,150/20kV transf	0.146	0.012	
3units, 20kV Switchgears	0.051	0.017	
Substation building	-	0.524	
Guidance Fee	0.065	0.007	
	0.882	0.816	1.705
19.GILI TIMUR			
1x150kV line bay	0.339	0.128	
Guidance Fee	0.034	0.003	
	0.373	0.131	0.505
20.KERTOSONO			
1x70kV transf. bay	0.169	0.105	
Guidance Fee	-	-	
	0.169	0.105	0.275
21.MOBILE TRANSFORMER			
1x30MVA,150(70)/20kV transformer	0.438	0.035	
Guidance Fee	0.014	0.001	
	0.452	0.036	0.488
22.NEW MADIUN			
1x150kV transf. bay	0.281	0.128	
1x20MVA,150/20kV transf	0.292	0.023	
4units, 20kV Switchgears	0.068	0.023	
Guidance Fee	0.031	0.003	
	0.672	0.177	0.850
23.TUREN			
1x70kV line bay	0.146	0.105	
Guidance Fee	-	-	
	0.146	0.105	0.252
TOTAL	26.260	12.525 (12.626) US$	38.886

1US$=Rp992

Table 3.1-28 SUBSTATION PROJECT (1/3)

EAST JAVA (1988/89)

Base Cost:1983

No. SUBSTATION	F C (US$ MILLION)	L C ($RPx10^9$)	L C (US$ MILLION)	TOTAL (US$ MILLION)
1.SUKOLILO				
1x50MVA,150/20 transformer	0.73	0.058		
1x150kV transformer bay	0.281	0.128		
10units, 20kV switchgears	0.168	0.058		
Guidance Fee	0.031	0.003		
	1.210	0.247	0.248	1.458
2.BANYUWANGI				
1x20MVA,150/20 transformer	0.292	0.023		
1x150kV transformer bay	0.281	0.128		
4units, 20kV switchgears	0.068	0.023		
Guidance Fee	0.031	0.003		
	0.672	0.177	0.178	0.850
3.PETROKIMIA				
1x30MVA,150/20 transformer	0.438	0.035		
1x150kV trasformer bay	0.281	0.128		
6units switchgears	0.102	0.035		
Guidance Fee	0.031	0.003		
	0.852	0.201	0.202	1.054
4.UJUNG				
1x30MVA,70/20 transformer	0.404	0.035		
1x70kV transformer bay	0.169	0.010		
6units, 20kV switchgears	0.102	0.035		
Guidance Fee	0.014	0.001		
	0.689	0.081	0.082	0.771
5.WARU				
1x50MVA,150/20 transformer	0.730	0.058		
1x150kV transformer bay	0.281	0.128		
10 units switchgears	0.168	0.058		
Guidance Fee	0.031	0.003		
	1.210	0.247	0.249	1.459

Table 3.1-28 SUBSTATION PROJECT (2/3)

EAST JAVA (1988/89)

Base Cost:1983

No. SUBSTATION	F C (US$ MILLION)	L C ($RPx10^9$)	L C (US$ MILLION)	TOTAL (US$ MILLION)
6.KERTOSONO				
2x70kV line bays	0.350	0.023		
1x70kV transformer bay	0.169	0.010		
1x10MVA,70/20 transformer	0.135	0.012		
3units switchgears	0.051	0.017		
Guidance Fee	0.014	0.002		
	0.719	0.064	0.065	0.784
7.TULUNGAGUNG				
1x70kV line bay	0.160	0.011		
1x70kV transformer bay	0.169	0.010		
1x20MVA,70/20 transformer	0.270	0.023		
4units switchgears	0.068	0.023		
Guidance Fee	0.014	0.002		
	0.681	0.069	0.070	0.751
8.JEMBER				
1x20MVA,150/20 transformer	0.292	0.023		
1x150kV transformer bay	0.281	0.128		
4units switchgears	0.068	0.023		
Guidance Fee	0.031	0.004		
	0.672	0.178	0.180	0.852
9.NEW KEDIRI				
1x30MVA,150/20 transformer	0.438	0.035		
1x150kV transformer bay	0.281	0.128		
1x70kV line bay	0.160	0.011		
6units switchgears	0.102	0.035		
Guidance Fee	0.031	0.004		
	1.012	0.213	0.214	1.226

Table 3.1-28 SUBSTATION PROJECT (3/3)

EAST JAVA (1988/89)

Base Cost:1983

No. SUBSTATION	F C (US$ MILLION)	L C ($RPx10^9$)	L C (US$ MILLION)	TOTAL (US$ MILLION)
10.MAGETAN				
1x20MVA,70/20 transformer	0.27	0.023		
1x70kV transformer bay	0.169	0.010		
4units switchgears	0.068	0.023		
2x70kV line bay	0.350	0.023		
Substation building		0.524		
Guidance Fee	0.014	0.002		
	0.871	0.605	0.610	1.481
11.KARANGKATES				
1x70kV line bay	0.160	0.011	0.011	0.171
12.SENGGURUH				
1x70kV line bay	0.160	0.011	0.011	0.171
13.NEW MADIUM				
3x70kV line bays	0.511	0.034	0.035	0.546
14.MOJOKERTO				
1x70kV line bay	0.160	0.011	0.011	0.171
TOTAL	9.579	2.149	2.166	11.745

Table 3.1-29 Direct Cost of D/L

As of Apri. 1984

1987/88

ITEM	Quantity	Unit Cost		F.C.	L.C.		Total
		F.C.($)	L.C.(10^3RP)	Cost($10^6$$)	Cost(10^9Rp)	Cost($10^6$$)	Cost($10^6$$)
M.V.Lines	115KM	9,405	4,310	1.082	0.496	0.500	1.582
Distribution Tr.	332 unit	1,613	75	0.536	0.025	0.025	0.561
L.V.Lines	498KM	*5,181	1,520	2.580	0.757	0.763	3.343
Service Equipment	99,385 PCS	**44.4	17.15	4.413	1.705	1.719	6.132
Sectionalizing SW.	16 PCS	7,700	75	0.123	0.001	0.001	0.124
Sub Total				8.734	2.984	3.008	11.742

1988/89

ITEM	Quantity	Unit Cost		F.C.	L.C.		Total
		F.C.($)	L.C.(10^3Rp)	Cost($10^6$$)	Cost(10^9Rp)	Cost($10^6$$)	Cost($10^6$$)
M.V.Lines	489.5KM	9,405	4,310	4.604	2.110	2.127	6.731
Distribution Tr.	994 unit	1,613	75	1.603	0.075	0.076	1.679
L.V.Lines	1,939.92KM	*5,181	1,520	10.051	2.949	2.973	13.024
Service Equipment	298,200 PCS	**44.4	17.15	13.240	5.114	5.155	18.395
Sectionalizing SW.	68 PCS	7,700	75	0.524	0.005	0.005	0.529
Sub Total				30.022	10.253	10.336	40.358

NOTE

* Proportion of L.V.Line — New Line : Line under Built=90.4KM:24.6KM

Unit Cost of L.V.Line $= 5,415\text{x}\frac{90.4}{115} + 4,320\text{x}\frac{24.6}{115} = 5,181(\$\text{-F.C.})$

$1,910\text{x}\frac{90.4}{115} + 1,180\text{x}\frac{24.6}{115} = 1,520(\text{x}10^3\text{RpL.C.})$

** Proportion of Service Equipment — Residential : Commercial : Industrial

=96,641PCS:2.619PCS:125PCS

Unit Cost of S.E. $= 17\text{x}\frac{96,641}{99,385} + 72\text{x}\frac{2,619}{99,385} + 20,330\text{x}\frac{125}{99,385} = 44.0(\text{x}10^3\text{Rp})$

$=44.4(\$\text{-F.C.})$

$= 17\text{x}$ " $+21\text{x}$ " $+ 1,702\text{x}$ " $=17.15(\text{x}10^3\text{Rp-L.C.})$

Table 3.1-30 Engineering Cost

(IN 10^6 US$)

ITEM \ YEAR	87/88	88/89
Base Cost		
F.C. Remuneration	2.667 (302M.M)	
Others	0.406	
Sub Total	3.073 → Direct costx6.8%	2.963 ← Direct costx7%
L.C.	0.756 → F.C. x24.6%	0.741 ← F.C. x25%
Contingency		
F.C.	0.307 ← Base costx10%	0.296 ← Base costx10%
L.C.	0.076	0.074
Total F.C.	3.380	3.259
Total L.C.	0.832	0.815

Table 3.1-31 BREAKDOWN OF PROJECT COSTS

(Base cost as of Apr., 1984)
(Unit : US$ × 10^6)

Year / Item	Total			1984/1985		1985/1986		1986/1987		1987/1988		1988/1989		1989/1990			
	F/C	L/C	Total	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C
1. Economic Costs	102.660	44.300	146.960	0.338	0.125	23.600	15.429	45.033	18.437	27.894	8.538	5.795	1.771				
1.1. Direc Costs	87.292	38.775	126.067			20.236	13.688	39.282	16.349	23.542	7.350	4.232	1.388				
a) Transmission Lines	9.975 2.722	9.254 1.385	19.229 4.107			4.489	5.090	4.489 1.225	3.239 0.762	0.997 1.225	0.925 0.485	0.272	0.138				
b) Substations	26.260 9.579	12.626 2.166	38.886 11.745			11.817	6.944	11.817 4.311	4.419 1.191	2.626 4.310	1.263 0.758	0.958	0.217				
c) Distribution Lines	8.734 30.022	3.008 10.336	11.742 40.358			3.930	1.654	3.930 13.510	1.053 5.685	0.874 13.510	0.301 3.618	3.002	1.033				
1.2. Physical Contingencies	8.729	3.878	12.607			2.024	1.369	3.928	1.635	2.354	0.735	0.423	0.139				
1.3. Engineering Costs	3.380 3.259	0.832 0.815	4.212 4.074	0.338	0.125	1.014 0.326	0.250 0.122	0.845 0.978	0.208 0.245	1.183 0.815	0.249 0.204	1.140	0.244				
2. Escalation	11.442	11.014	22.456			1.180	1.851	4.616	4.690	4.397	3.457	1.249	1.016				
3. Construction Costs Total	114.102	55.314	169.416	0.338	0.125	24.780	17.280	49.649	23.127	32.291	11.995	7.044	2.787				

Table 3.1-32 Disbursement Schedule

(IN %)

Cost	Planning		84/85	85/86	86/87	87/88	88/89
Direct Cost	1987	F.C.		45	45	10	
		L.C.		55	35	10	
	1988	F.C.			45	45	10
		L.C.			55	35	10
Engineering Cost	1987	F.C.	10	30	25	35	
		L.C.	15	30	25	30	
	1988	F.C.		10	30	25	35
		L.C.		15	30	25	30

Table 3.1-33 IMPLEMENTATION SCHEDULE

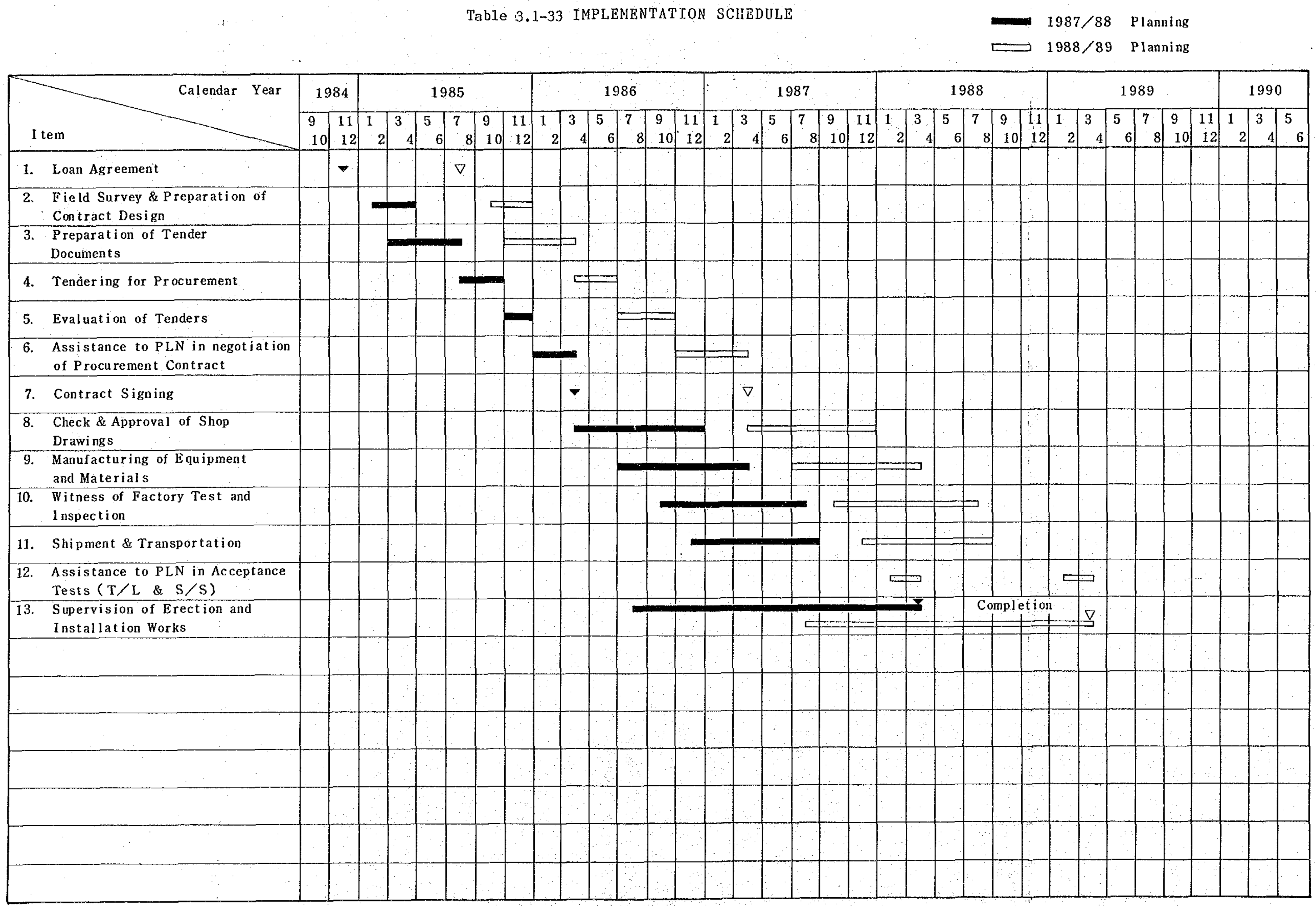
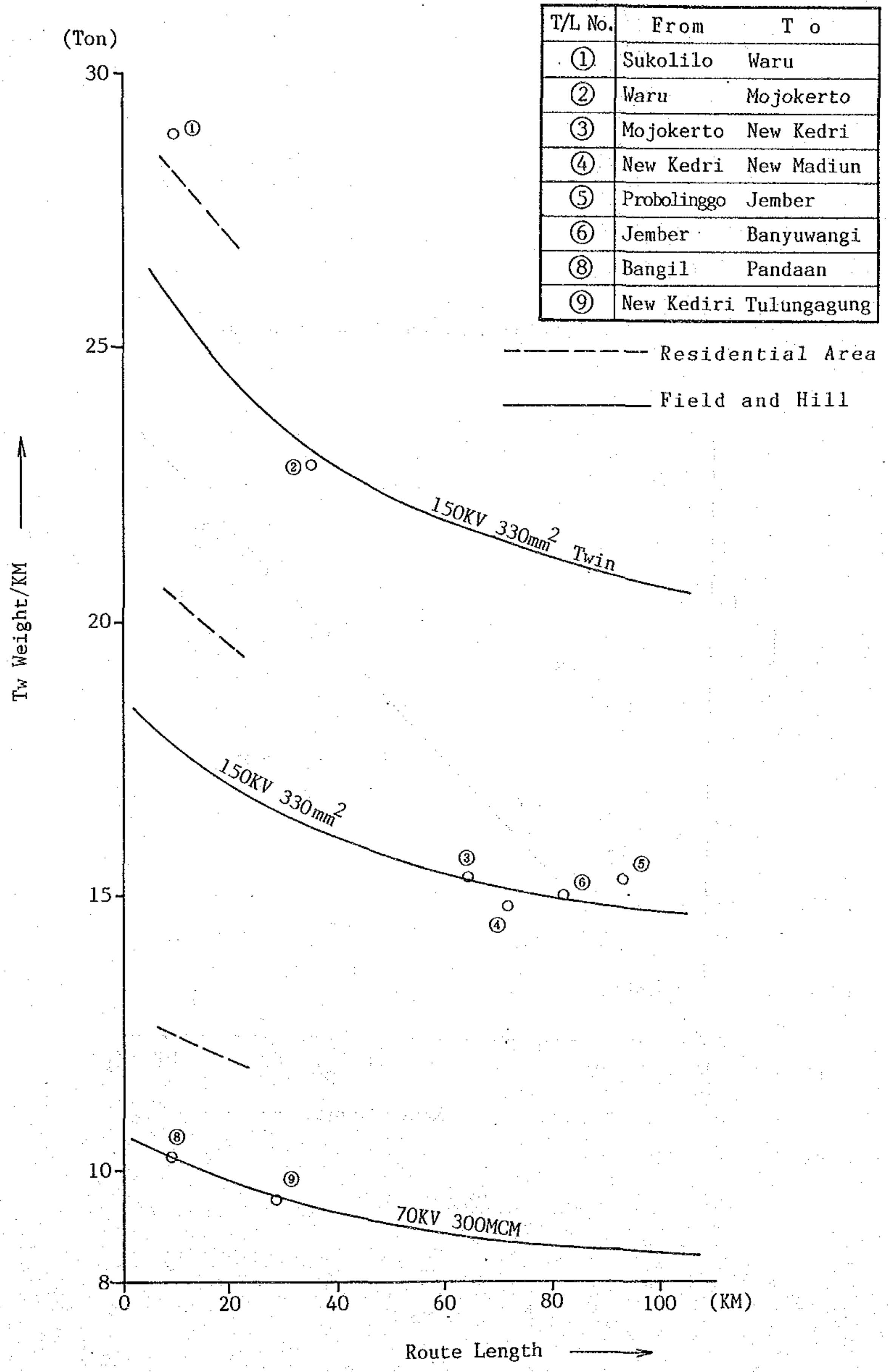


Fig 3.1-1 Standard Weight of Tower Per KM



T/L No.	From	To
①	Sukolilo	Waru
②	Waru	Mojokerto
③	Mojokerto	New Kedri
④	New Kedri	New Madiun
⑤	Probolinggo	Jember
⑥	Jember	Banyuwangi
⑧	Bangil	Pandaan
⑨	New Kediri	Tulungagung

Fig 3.1-2 Proportion of Tw (Ten/Sup:1/n)

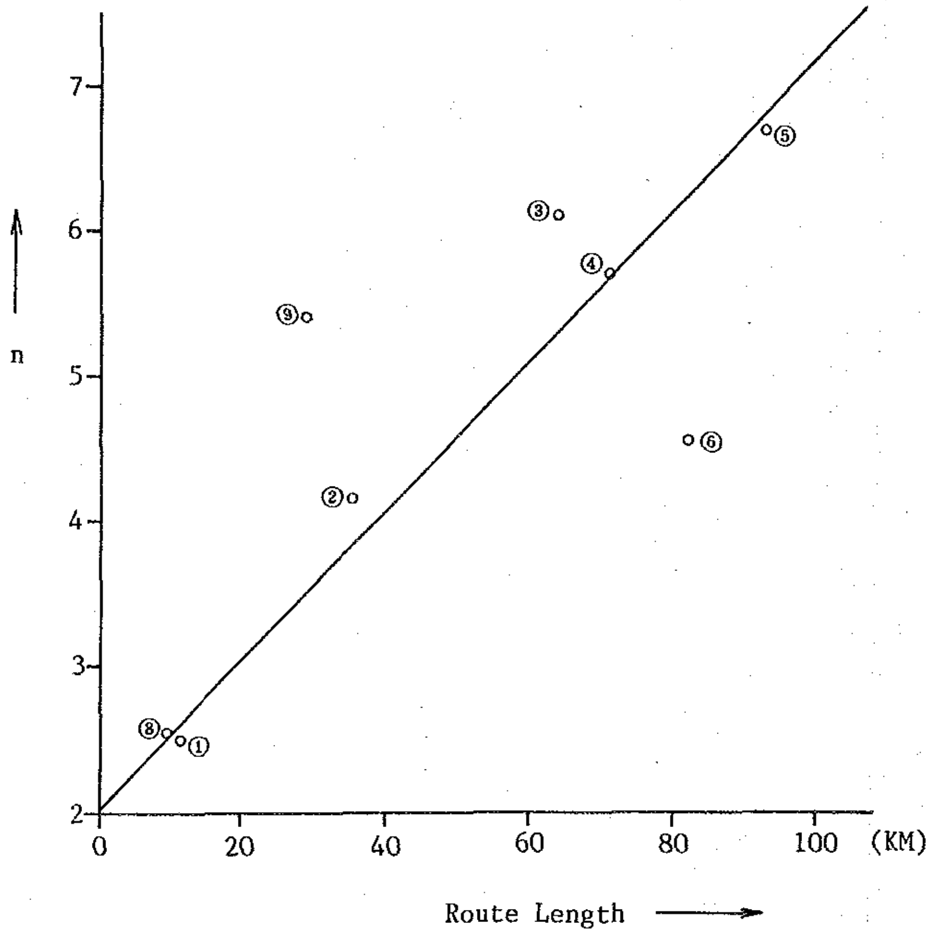


Fig 3.1-3 Mean Span Length

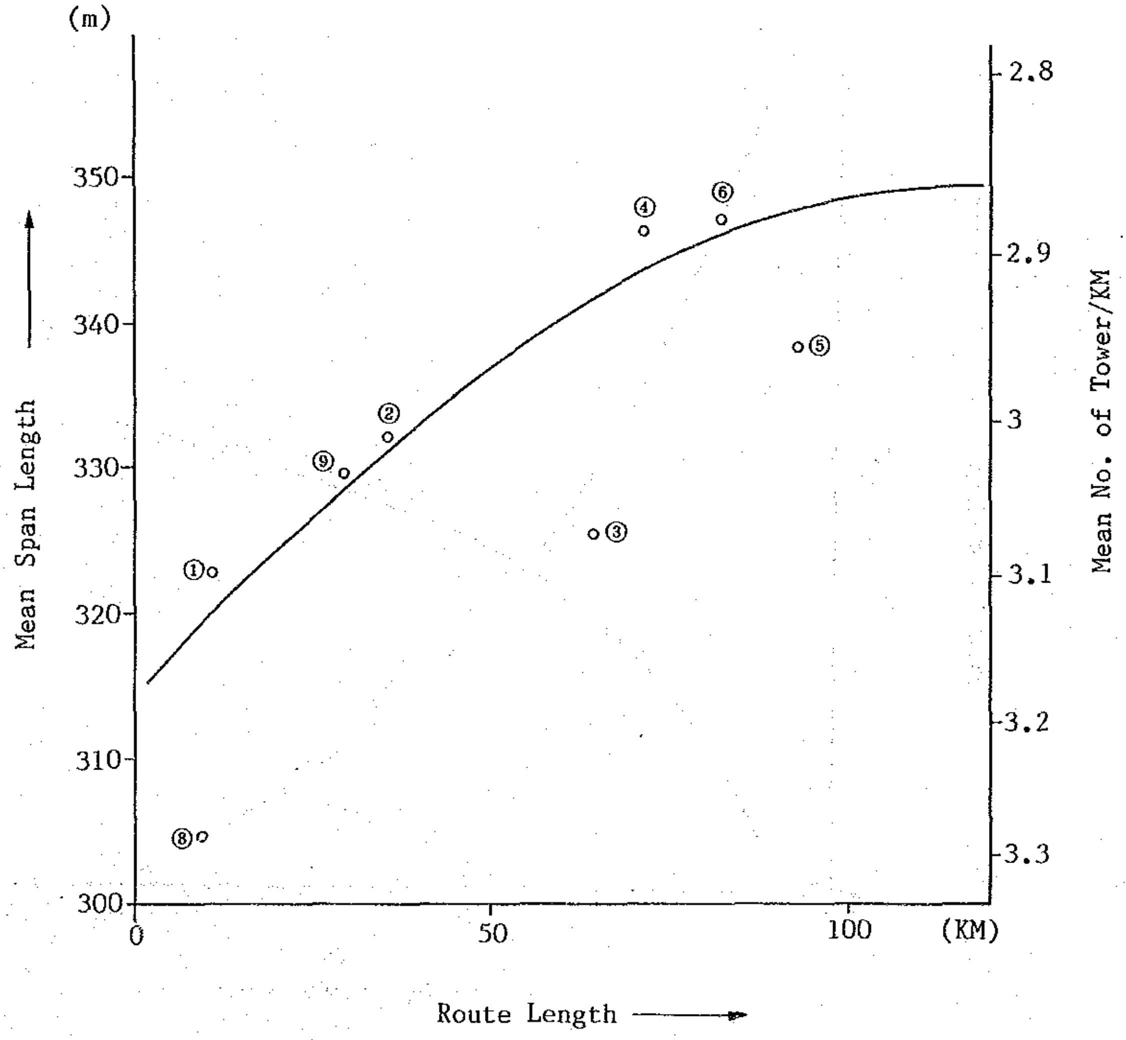


Fig. 3.1-4 Mean No.of Tower/KM

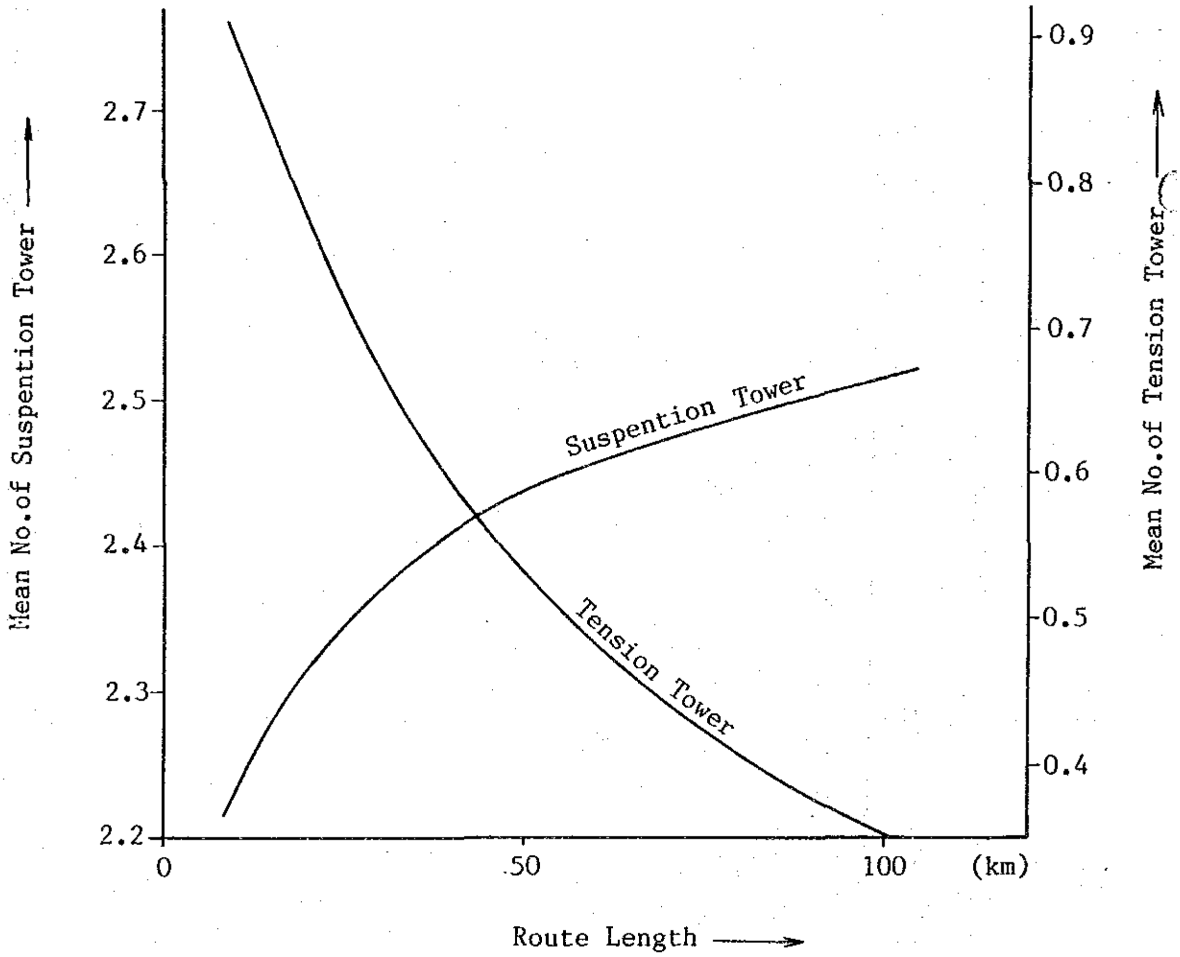
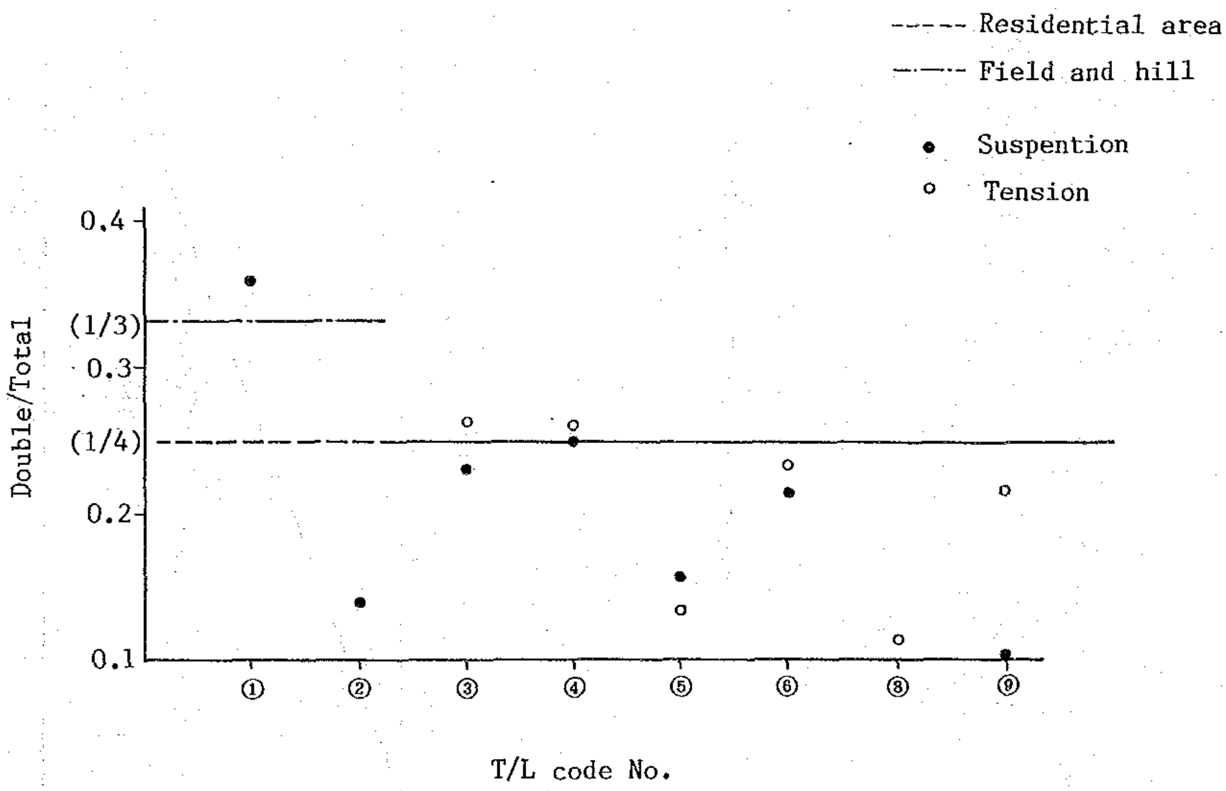


Fig 3.1-5 Proportion of Insulator(Double/Total)



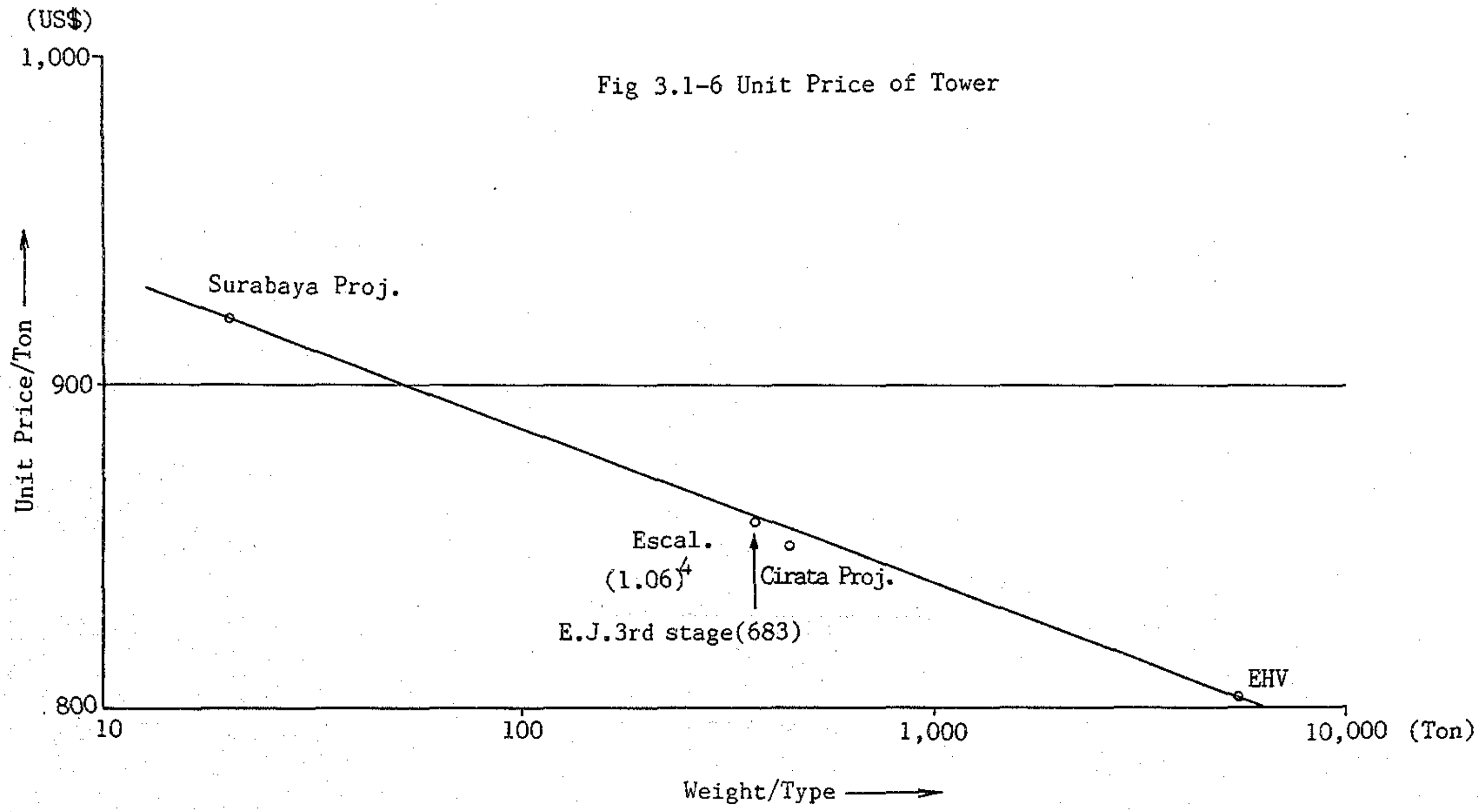


Fig 3.1-6 Unit Price of Tower

Fig 3.1-7 150kV/20kV Tr Unit Price

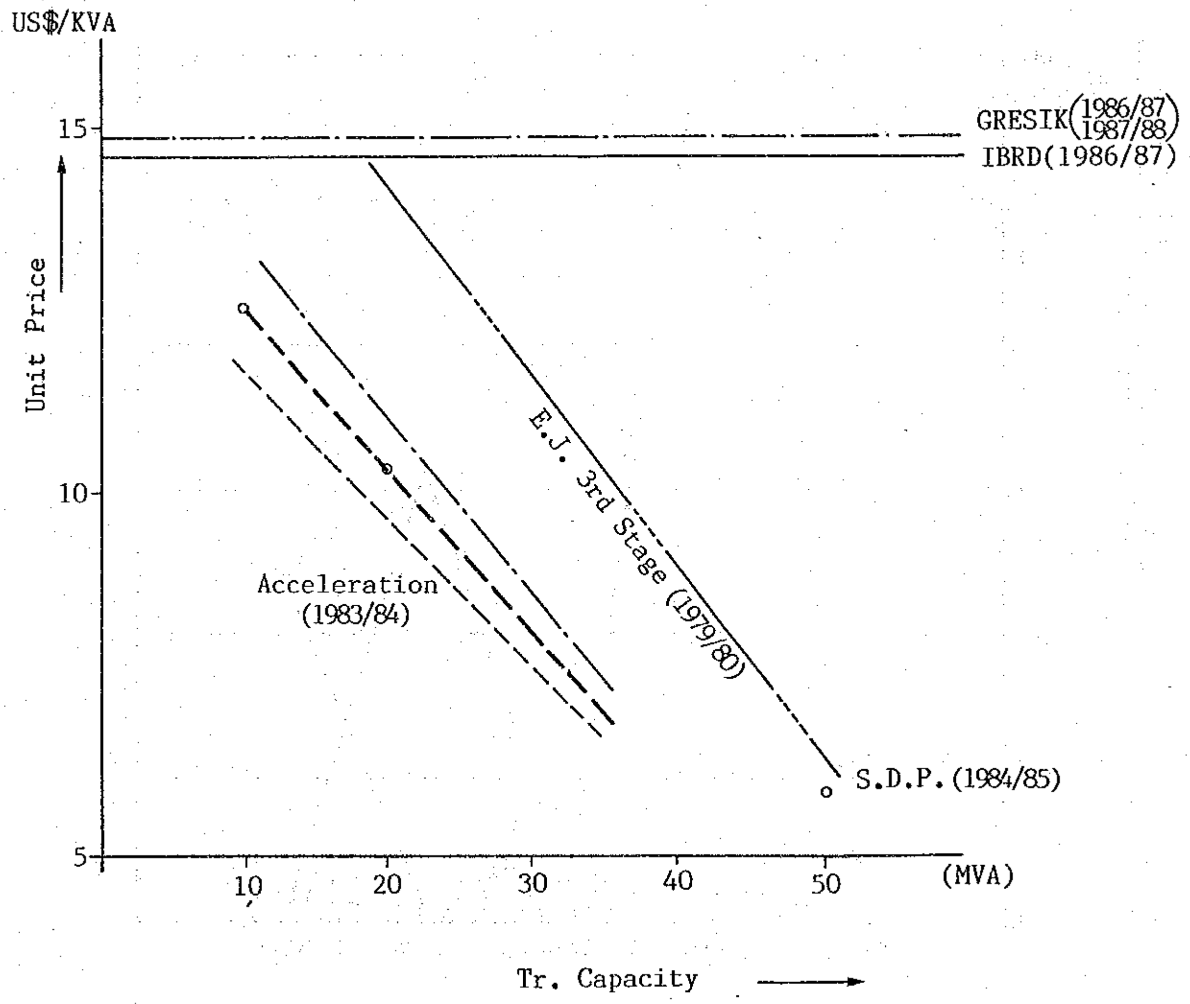


Fig 3.1-8 Transmission Line Planning

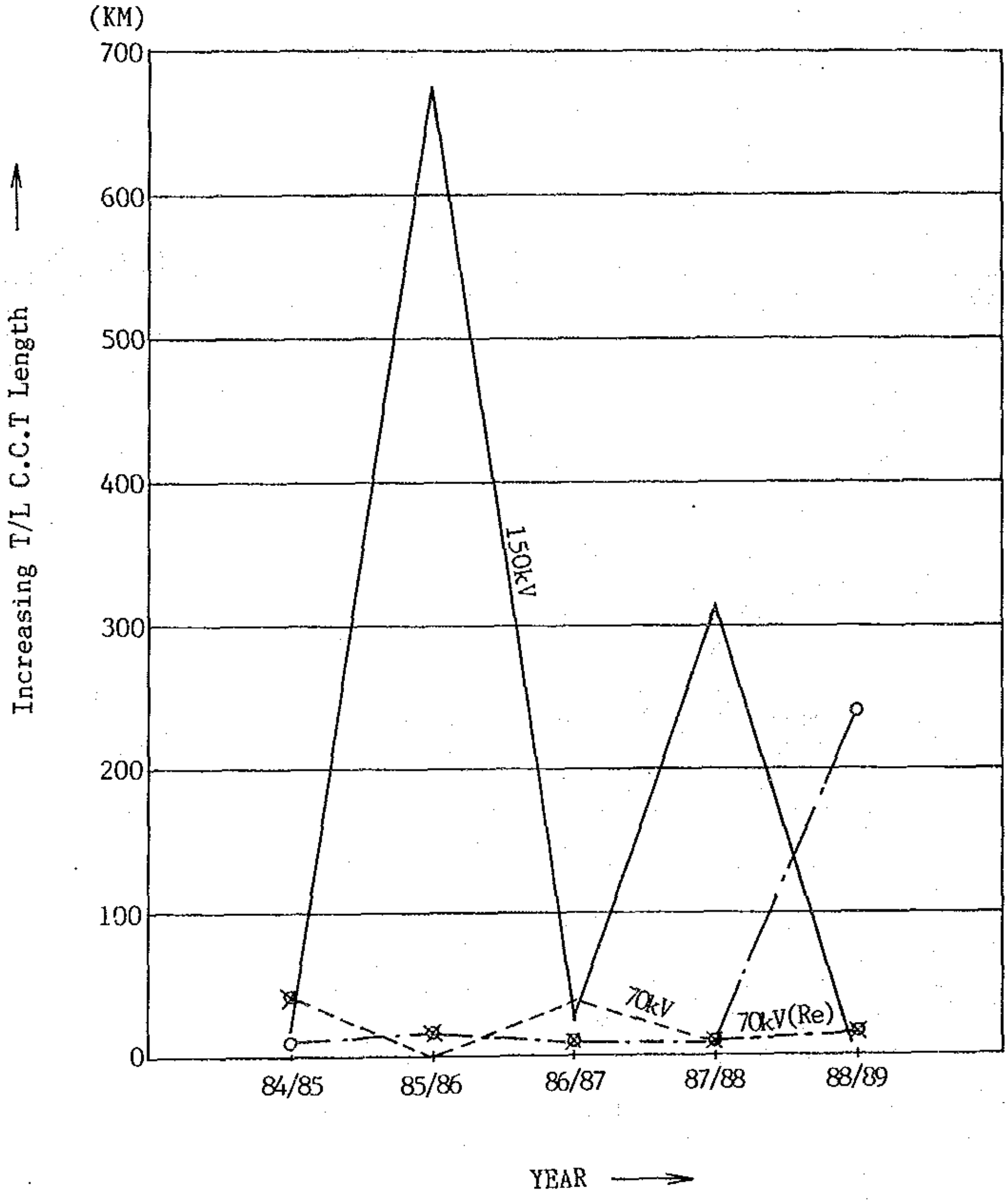
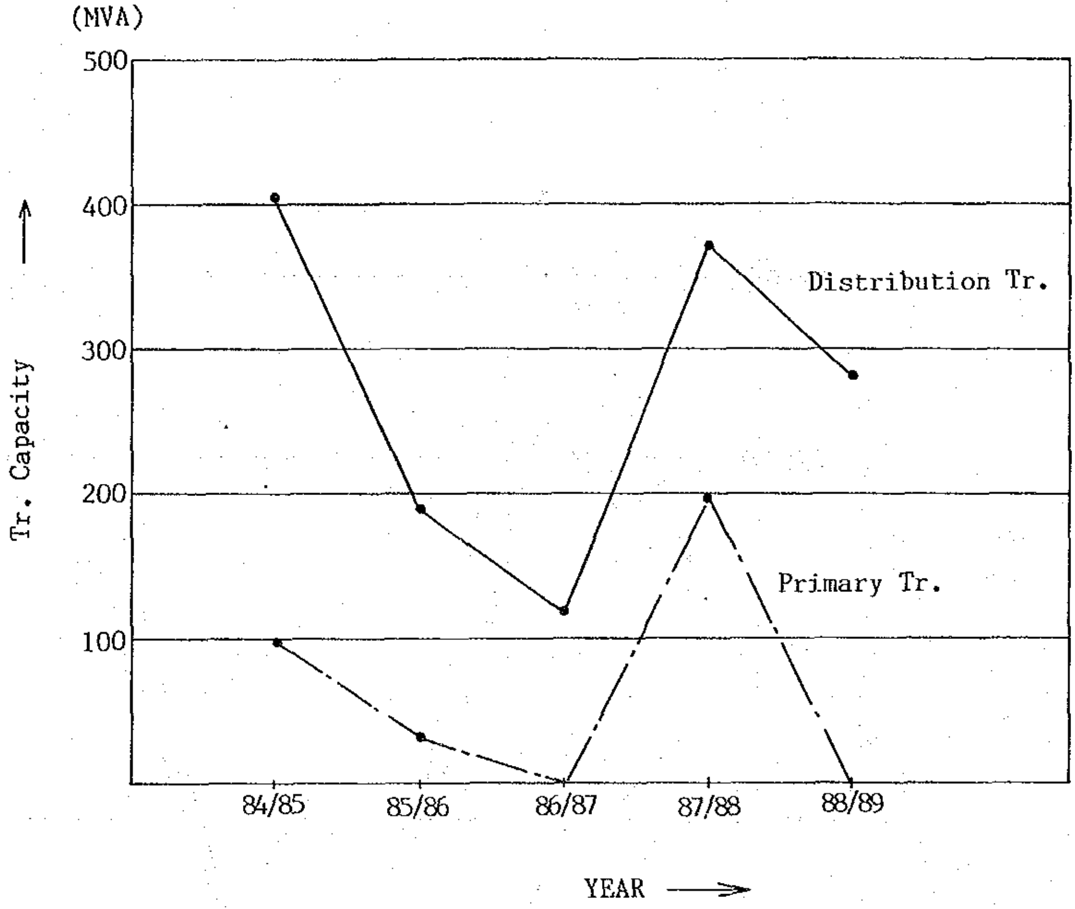


Fig 3.1-9 Substation Planning

Transformer



Feeder Bay

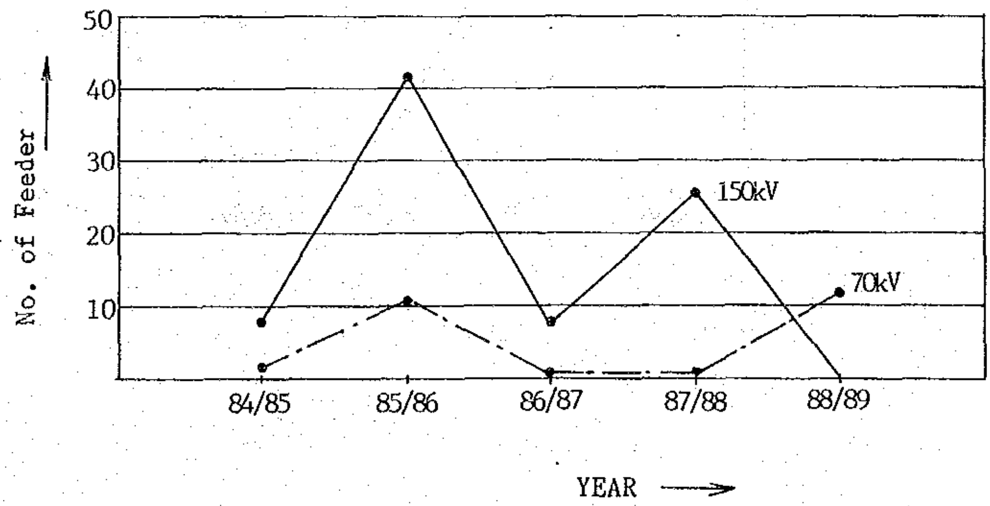


Fig 3.1-10 Distribution Planning

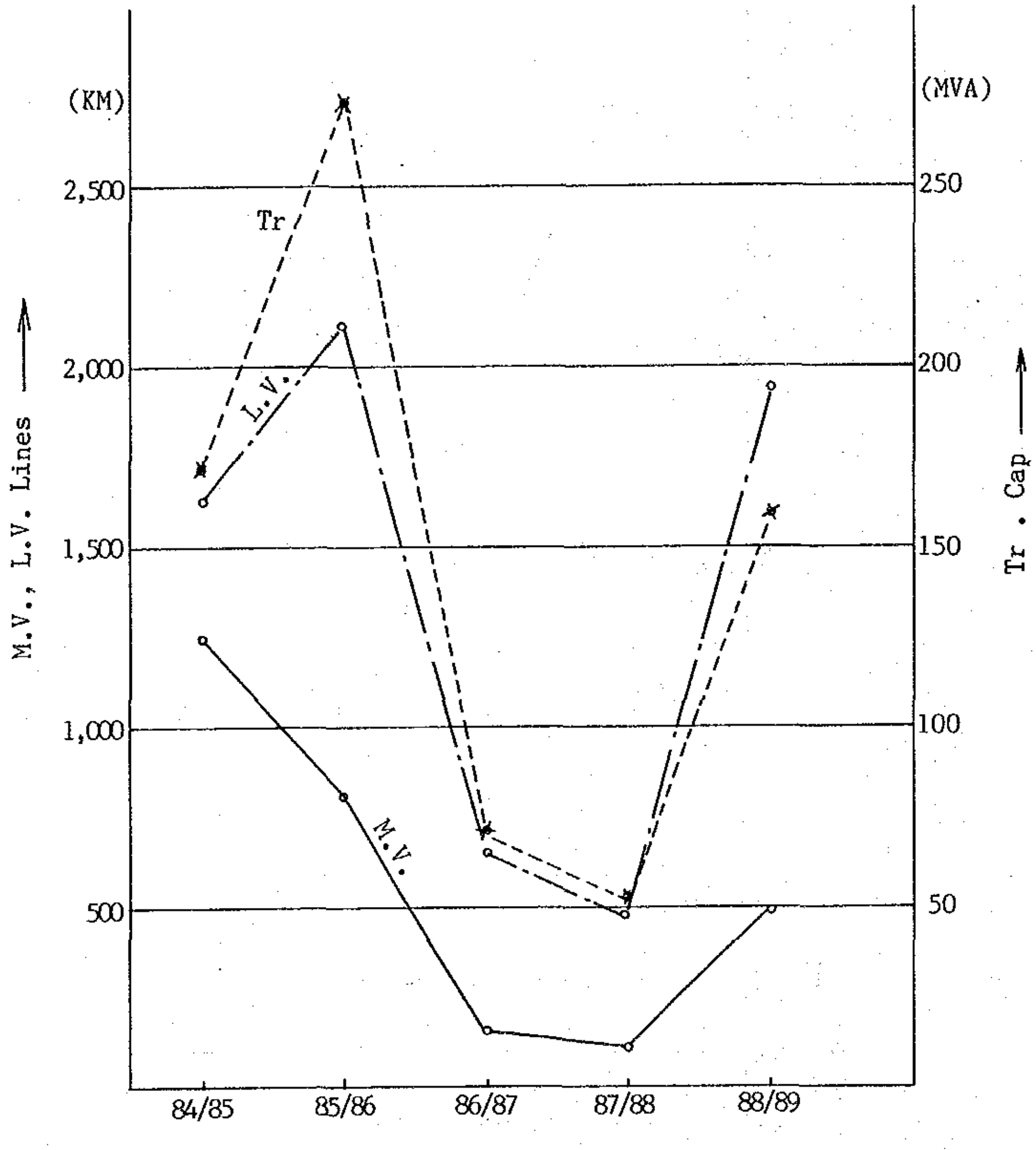
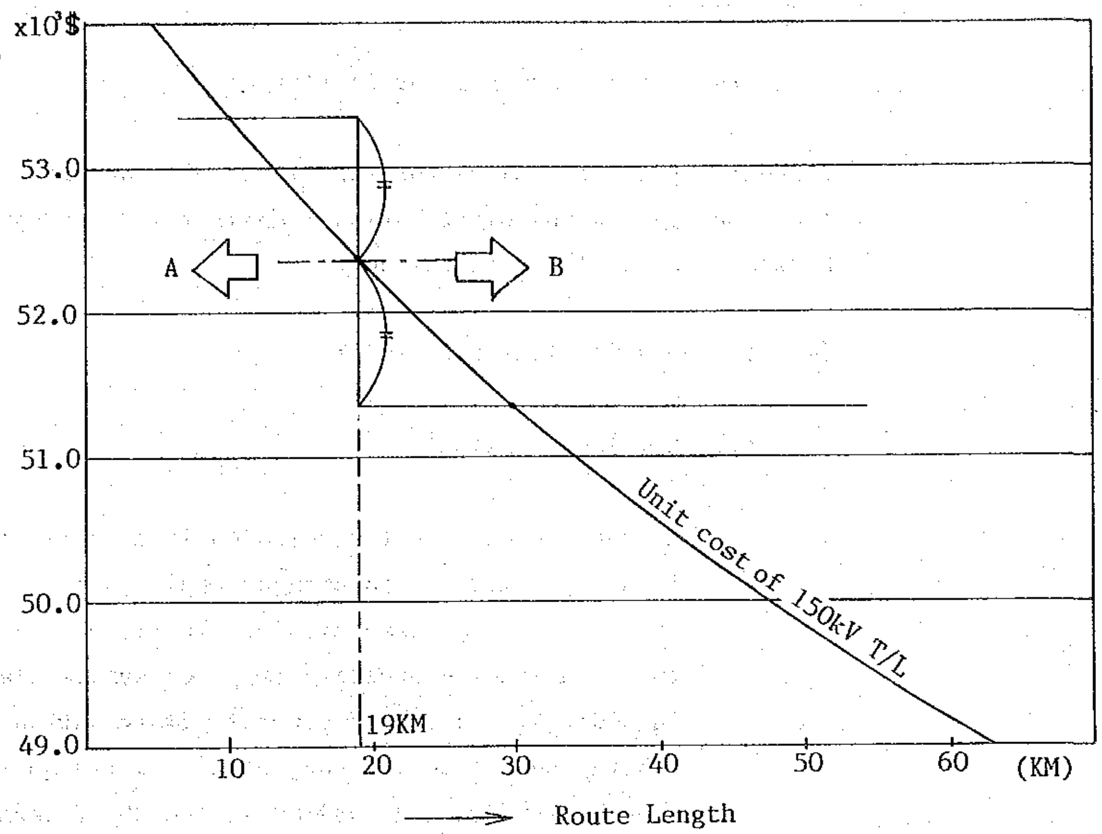


Fig 3.1-11 Boundary of A & B



3.2. Justification of Short-term Program

3.2.1. Technical Justification

(1) Standard of the plannings for facilities

Standard of the plannings for facilities of transmission line, substation and distribution line in the Short-term Program was concluded as follows:

(a) Transmission line facilities

(i) New installation

As the capacity of transmission line facilities is not possible to be changed easily, it is possible for new transmission line to secure the transmission capacity of power system plan in 2003/04. To supply power to distribution substation is the main object of new transmission line in 1987/88 and 1988/89 in the Short-term Program.

On the other hand, the power system for 150 kV distribution substations is based on the transmission system looped from connecting substation by every area.

The new 150 kV transmission line was planned and standardized in accordance with transmission capacity by the area shown in Table 3.2-1.

To supply power to local distribution substations of the remote areas in the East Java Province, new 70 kV transmission line with 300 MCM A.C.S.R. was planned.

(ii) Addition of 2nd c.c.t.

Addition of 2nd c.c.t. of transmission line should be planned first when the shortage of transmission capacity is anticipated as well as the execution thereof is on a paying basis.

In this study, the following cases were considered for planning of the addition of 2nd c.c.t.

- Case of 150 kV transmission line

  The reliability of transmission line was so high that no extension was required in particular. However, addition of 2nd c.c.t. of the transmission line, having a direct influence on socity in case of the failure of the power supply, was planned.

- Case of 70 kV transmission line

  The average tripout rate of 70 kV transmission line shows approx. three times as much as that of 150 kV; 12.41 cases/100 KM in rainy season. The reliability thereof was apparently low, so that addition of 2nd c.c.t. of this transmission line was planned in early stage.

(iii) Rehabilitation works

For 70 kV transmission line installed on or before 1967, 50 mm^2 H.D.C.C. or 85 mm^2 A.C.S.R. has been applied.

A serious situation such as the failure of the power supply for long time is anticipated because of triteness as well as high rate of tripout of the facilities.

Therefore, the plan to improve and converse these middle size conductors to the larger ones in sequence was planned in consideration of importance of load, effectiveness of loss reduction and allowance of facilities.

(b) Substation facilities

(i) Plan of new substations required was conducted with the basic consideration of load forecast in the Middle/Long-term Plan, promotion of electrification, voltage drop of M.V. distribution line and necessity of early land acquisition.

New substations planned to be constructed are as follows:

. Surabaya city

According to "Surabaya 2000 Team Master-Plan", fifteen sites for new substations in Surabaya city were prearranged, and nine sites of these were included in the Long-term Program.

Planning the period of new substations and the peak load of existing connecting substations; supplying power to the area at present, are shown in Fig. 3.2-1.

It is clarified by Fig. 3.2-1 that the increasing rate of 20 kV load in Waru S/S service area is the highest and number of new substations in this area is the most. Consequently, a new substation was planned to be constructed - in accordance with the Short-term Program - at Babatan in Waru S/S service area where the industrial load was required in early stage.

. Madura island

Madura is an island of 5,593 km^2 occupying 11.7% in area and 8.9% in population of the whole East Java Province.

Madura is divided into four power supplied areas. Each area has its own power supplying system by diesel generation respectively.

The electrification ratio in Madura, therefore, is still low (3%) being equivalent to 1/3 of the whole Java Island, and there are no noticeable industries. Accordingly, major power demand is load from pumps for irrigation and town water supply, driers for tobacco and salt factories. The power consumption in Madura is no more than 1.2% of the whole East Java Province.

In recent years, the execution of project to develop this island has been in active progress. As the first stage, the construction of some cement factories was set up in the southwest area of Madura. Besides, the power interconnection by 150 kV submarine cable directly from Gresik P/S is now being prepared steadily higher than that by diesel power system for three years up to 1990. But this tendency is reversed on and after 1994 making a large difference year by year. Considering the above-mentioned, it is apparently profitable to introduce 150 kV power system.

Since peak load up to 1987 can be supplied by existing facilities, it is adequate to introduce 150 kV power system in 1988. To start 150 kV power system in 1988, installation of transmission/substation facilities should be completed in 1987/88.

. Local distribution substation

New construction of distribution substation excluding Surabaya city was planned in consideration of the present situation of distribution line and facilities of connecting substations, tendency of power demand in the future and difficulity of land acquisition.

Table 3.2-2 shows concrete plan for new construction of substations.

Besides, 5% of 20 kV (1 kV) was considered for the service level of voltage drop in 20 kV distribution line.

(ii) Extension of transformer

Necessary capacity of substations was obtained by the following formula to plan the extension of transformers in substation when for the construction to be completed up to 1985 with the co-operation of United Kingdom.

Taking this opportunity, the modernization for the whole Madura: spread of electrification, positive introduction and promotion of industries, is about to be commenced. For example, the project of trunk transmission line crossing over the island from west to east, is now in progress. Furthermore, the construction of four substations connected to this trunk line is expected to be materialized.

Since the power demand under the said preconditions is hard to forecast, forecast figures for power demand between PLN and JICA show considerable difference.

In this study, the adequency of the project using forecast figures of JICA based on the histrical records of power consumption was studied to make sure of the payability on the introduction of 150 kV power system. Fig.3.2-2 shows forecast figures of load in the future - excluding load of some cement factories and Gili Timur S/S - in Madura as well as system plan - to cope with this load - composed of two cases: one is the extension of diesel power stations and the other is the new construction of substations for 150 kV power system.

Fig.3.2-1 shows unit cost of power by existing/ future diesel power system as well as 150 kV one. According to Fig.3.2-1, it is clear that unit cost of power by 150 kV power system is thereof the necessary capacity exceeded the capacity of existing facilities.

Regard to the extended capacity, furthermore, it was considered that the capacity was equivalent to the increasing of power for five years after the initial extension.

$$\text{Necessary capacity} = \text{Peak Load} \times \frac{1.15}{0.85}$$

1.15 : 1 + Diversity Factor (0.03) +
Allowance Factor (0.12)

0.85 : Power Factor

. Connecting transformer

Planning the unit capacity of 150/70 kV connecting transformer by 50 MVA, extension of substations where transformer capacity would be short in 1987/88 was formulated.

. Distribution transformer

Supporsing the fault of transformer, estimation of existing transformers capacity was conducted as follows:

In case of substation with trite 70/20 kV transformers, estimation of transformer capacity was conducted excluding the largest unit capacity of 70/20 kV transformer. Because the fault of excluded one was supposed.

In case of substation with only one unit of transformer, estimation of the substation capacity was conducted by transmitted power from neighbor substation through distribution line. Because the fault of only one transformer was supposed.

In this case, 3.5 MW/1 c.c.t. distribution line of transmitted power was considered to be possible.

(c) Distribution facilities

(i) Planning of 1987/88

Expansion planning for distribution facilities is now in progress agreesively for three years during 1984/85 to 1986/87 in the East Java Province. Giving priority to transmission/substation facilities, cosequently, the expansion thereof was formulated in 1987/88.

In this expansion planning of distribution facilities, therefore, the execution thereof was limited to two Cabangs; Pamekasan and Kediri, which were not included in the planning of 1986/87.

(ii) Planning of 1988/89

Planning for distribution facilities of all Cabangs in the East Java Province was investigated, and formulated in the order of necessity.

All Cabangs without Pasuruan were considered to be included in the planning, and the quantity and the cost of construction were estimated to be nearly at the average level of the past four years.

(2) Justification of facilities planning

Each facility based on the standard of plannings, the above was tried to be justificated concretely.

Table 3.1-21, Table 3.1-22, Table 3.1-23 and Table 3.1-24 show the relation between load and capacity of transmission/substation/distribution facilities.

Table 3.2-1 T/L System and Capacity in 2003

Average Peak Load of Distribution Substation in 2003

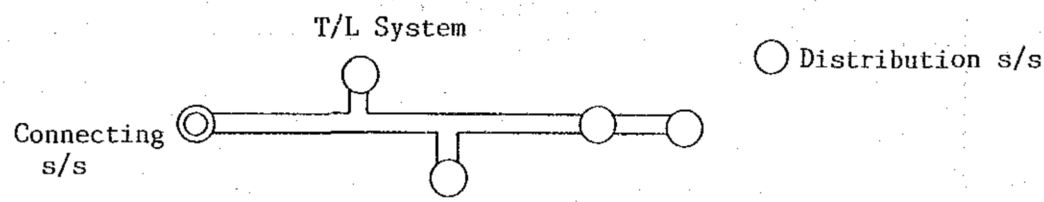
	Peak Load(MW) (M.V.+L.V.)	No of Distribution s/s	Average Peak Load(MW)
Surabaya and Surrounding	1,725	24	71.9
Othars	1,114	53	21.0

Necessary Capacity and Planning Capacity of T/L in 2003

	* Max.NO. of s/s	** Necessary Capacity (MW)	Planning (2.c.c.t)	
			Conductor Size	*** Capacity(MW)
Surabaya Center	4	332	$330mm^2$ xTwin	490
Surabaya Surrounding	3	242	$330mm^2$	245
Others	6	141	$330mm^2$ ($240mm^2$)	245 (197)

Note

* Maximun No.of Distribution s/s in T/L System



** Necessary Capacity = Average Peak Load x No.of s/s x Allowance(1.12)

*** Capacity = $\sqrt{3}$ Voltage x Current Carring Capacity x Power Factor x 1.5
= $\sqrt{3}$ x 150 x Current Carring Capacity x 0.85 x 1.5 x 10^{-3}(MW)

Table 3.2-2 Planning of New s/s exclude Surabaya and Madura

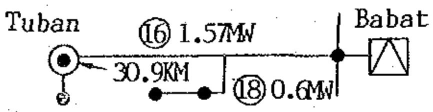
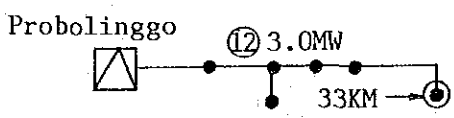
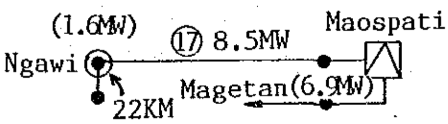
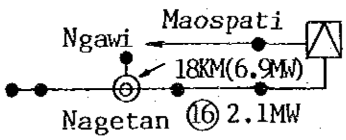
Item / New s/s	D/L Voltage drop(V),1998 — Distribution Line	Vg Drop	Future
Tuban		1,020V (5.1%)	Cement factory
Kraksaan		1,570V (7.9%)	Promotion of Electrification
Ngawi		1,110V (5.6%)	"
Magetan		1,080V (5.4%)	"
Paiton	———	———	T/L for construction work of coal P/S

Table 3.2-3. Capacity and Peak Load of T/L (1/2)

New Construction

Year	Name of T/L	Capacity of T/L (MW)				Peak Load (MW)			Necessary capacity (MW)
		Vg (kV)	No.of c.c.t	condu. (mm²)	capacity (MW)	1988 or 1989	2003 * No.of s/s	2003 Load	
1987	Krian-Babatan	150	2	330	245	4.5	3	188	211
"	Probolingo-Kraksaan	150	2	330	245	4.8	4	123	138
"	Kraksaan-Paiton	150	2	330	245	2.7	5	138	155
"	Ngawi-Incomer	150	2	240	197	1.6	1	2	2
"	Babat-Tuban	150	1/2	330	163	1.5	1	18	20
"	Gilitimur-Bangkalan	150	1/2	330	163	8.1	4	36	40
"	Bangkalan-Sampang	150	1/2	330	163	6.5	3	29	32
"	Sampang-Pamekasan	150	1/2	330	163	4.8	2	21	34
"	Pamekasan-Sumenep	150	1/2	330	163	2.2	1	12	13
1988	New Madium-Magetan	70	2	300 MCN	68	2.1	1	3	3

Note

* No.of s/s : No.of s/s in the T/L System

Additional Secend Circuit

Year	Name of T/L	Capacity of T/L(MW)				Peak Load (MW)			Necessary Capacity (MW)
		Vg (kV)	Candu. (mm²)	Capacity(MW) 1cct	Capacity(MW) 2cct	1988 or 1989	2003 No.of s/s	2003 Load	
1987	Sukolilo-Kenjeran	150	330	163	245	16.4	2	139	156
"	Turen-Incomer	70	300 MCM	45	68	6.6	1	17	19
1988	Tulungagung-Kediri	70	"	45	68	17.6	2	54	60
"	Karangkates-Sengguruh	70	"	26	41	8.3	1	5	11
"	Mojokerto-Madium	70	"	45	68	2.9	1	15.9	18

(2/2)

Rehabilitation

Year	Name of T/L	Capacity of T/L (MW)				Load (MW)		Necessary
		Existing		Planning		1983	1988 or 1989	Capacity
		condu.	cap.	condu.	cap.			(MW)
1987	Waru-Sawahan	$50mm^2$cu	40	300MCM	68	30.9	57.4	64
1988	Karangkates-Sengguruh	$50mm^2$cu	40	300MCM	68	2.1	14.7	*20

* Reliability and loss reduction

Table 3.2-4 Capacity and Peak Load of s/s (1/2)

New Construction

Year	Name of s/s	Capacity (MVA)		Load (MW)		Necessary Cap.(MVA)	
		Tr.	* D.L.	1988	1993	1988	1993
1987	Babatan	50	14.0	4.5	8.6	6.1	11.6
"	Kraksaan	20	7.0	2.1	4.2	2.8	5.7
"	Tuban	20	3.5	1.5	2.3	2.0	3.1
"	Ngawi	10	3.5	1.6	1.9	2.2	2.6
"	Paiton	20	7.0	2.7	3.6	3.7	4.9
"	Bangkalan	10	7.0	1.6	2.8	2.2	3.8
"	Sampang	10	10.5	1.7	3.6	2.3	4.9
"	Pamekasan	10	10.5	2.6	4.4	3.5	6.0
"	Sumenep	10	7.0	2.2	4.0	3.0	5.4
1988	Magetan	20	3.5	** 2.1	2.3	2.8	3.1

Note

* D.L. : Distribution Line Capacity from Next s/s

** Load, Necessary Cap. : 1989 & 1994

Additional Connecting Tr.

Year	Name of s/s	Capacity (MVA)		Load (MW)		Necessary Cap.(MVA)	
		existing	After Pl.	1988	1993	1988	1993
1987	Segoromadu	50	150	61.4	78.8	83.1	106.6
"	Mojokerto	35	85	29.3	40.2	39.6	54.4
"	New Kediri	35	85	33.9	46.2	45.9	62.5

Additional Distribution Tr.

Year	Name of s/s	Capacity (MVA)		Load (MW)		Necessary Cap (MVA)	
		Existing	After Pl.	1988or89	1993or94	1988or89	1993or94
1987	Segoromadu	20*(10)	50	20.8	26.7	28.1	36.1
"	Mojokerto	46 (16)	106	17.8	36.9	24.1	49.9
"	Rungkut	50((21))	100	57.6	66.3	77.9	89.7
"	Probolinggo	20 (10)	40	10.5	20.1	14.2	27.2
"	New Madium	30 (10)	50	13.7	23.9	18.5	32.3
1988	Sukolilo	80	130	49.63	97.7	67.1	130.0
"	Banyuwangi	20((0))	40	10.0	24.6	13.5	33.3
"	Petrokimia	30((3.5))	60	21.0	21.0	28.4	28.4
"	Ujung	32 (12)	62	11.4	17.9	15.4	24.2
"	Waru	50((10.5))	100	31.9	52.8	43.1	71.5
"	Kertosono	10((3.5))	20	3.5	5.7	4.7	7.6
"	Tulungagung	23 (13)	43	10.9	20.8	14.8	28.2
"	Jember	20((7))	40	11.3	18.1	15.3	24.5
"	New Kediri	30 (20)	60	15.0	28.8	20.3	39.0

Note * ( ) : Exclude one old 70kV/20kV Tr.

**(( )): Distribution Line Capacity from next s/s in case of one Bank s/s

Table 3.2-5 Peak Load and Planning of D/L

Item / Cabang	20KV Peak Load (MW)			Planning (1987-1988)		
	1986	1988	Growth	M.V.Line (KM)	Pole Tr. (UNIT)	L.V.Line (KM)
Surabaya Utara	97.57	122.48	24.91	40	340	478.5
Surabaya Selatan	186.90	241.60	54.70	47.5	400	1,080
Malang	54.07	69.93	15.86	54	51	76.5
Pasuwan	27.27	36.52	9.25	0	0	0
Kediri	25.12	34.09	8.97	49	174	261
Mojokerto	15.91	21.60	5.69	30	10	14.6
Madium	21.25	26.95	5.70	60	68	103.4
Jember	13.32	16.72	3.40	45	23	33
Banyuwangi	6.24	8.48	2.24	27	20	29.6
Situbondo	2.69	3.14	0.45	53	27	41.3
Pamekasan	6.11	8.11	2.00	199	213	320

Fig 3.2-1 20kV Peak Load at Connecting s/s in Surabaya

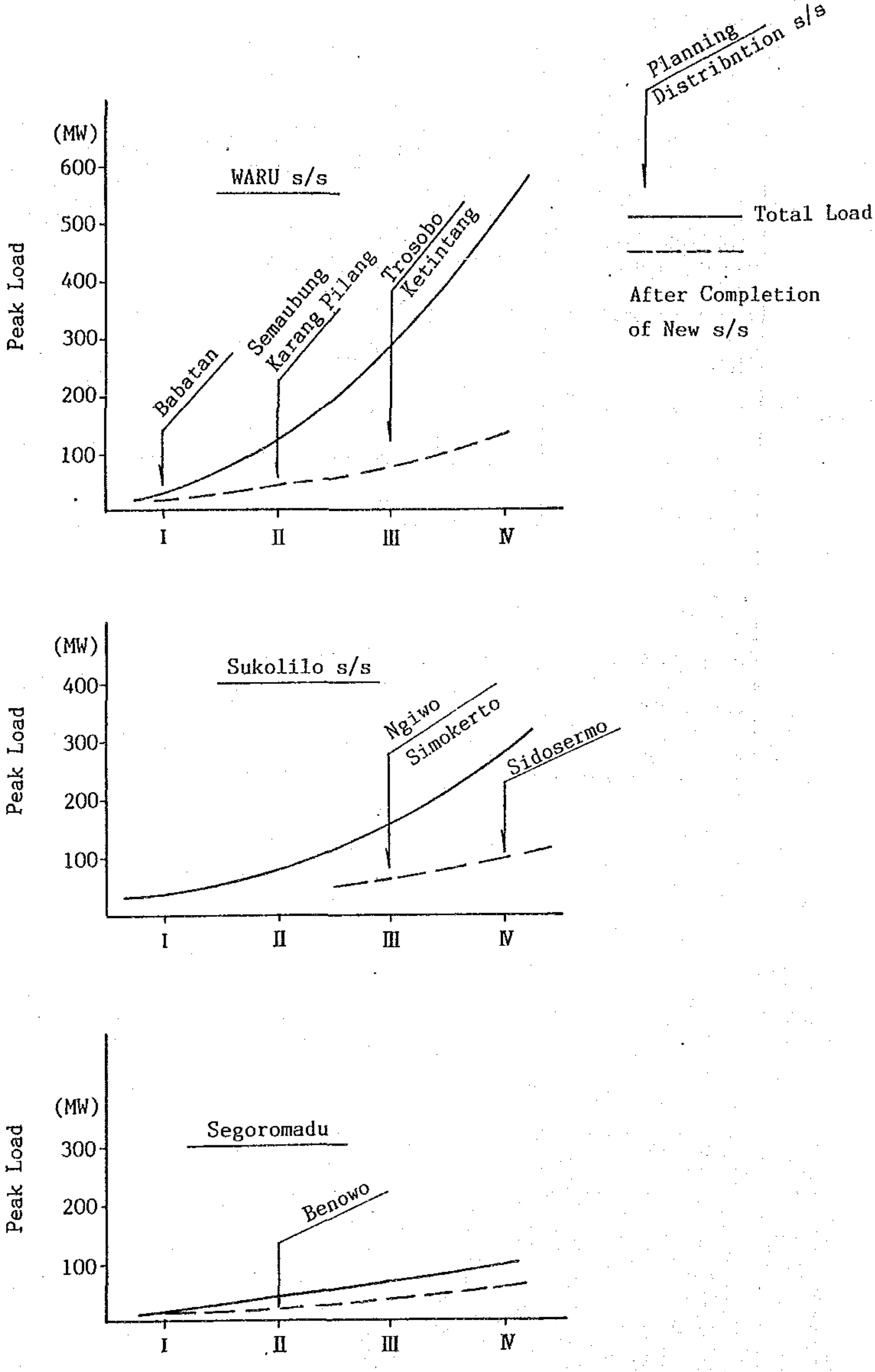
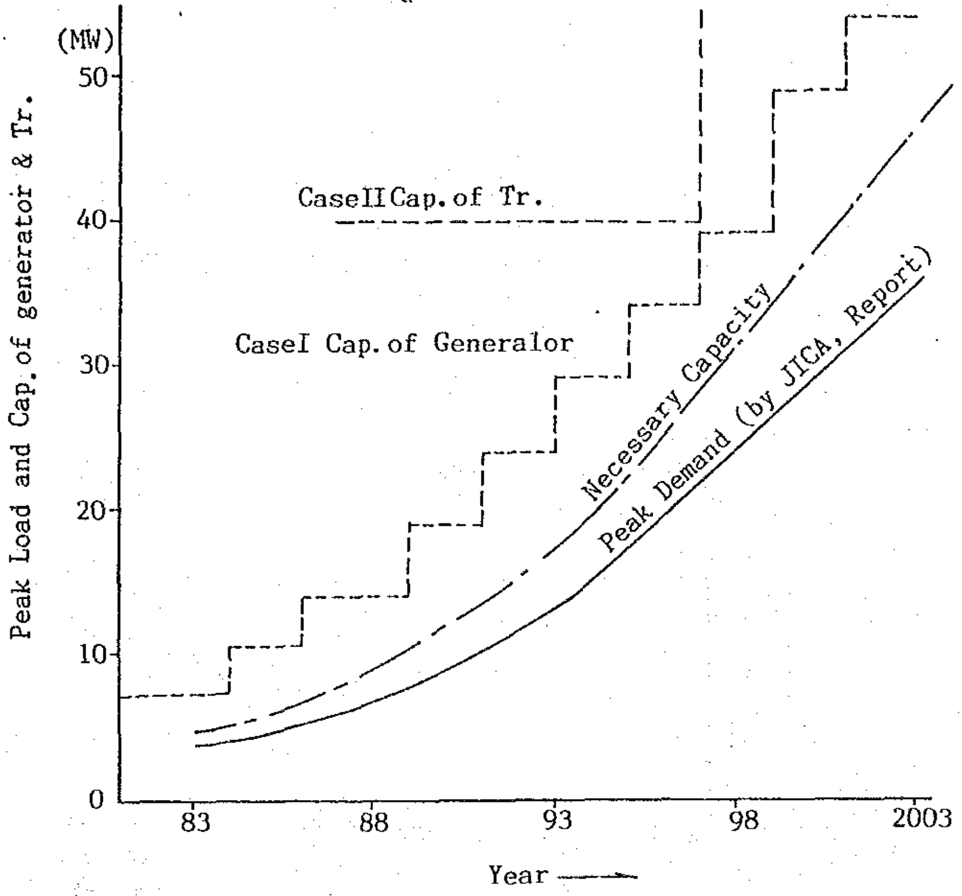


Fig 3.2-2 Planning in Madura Is.



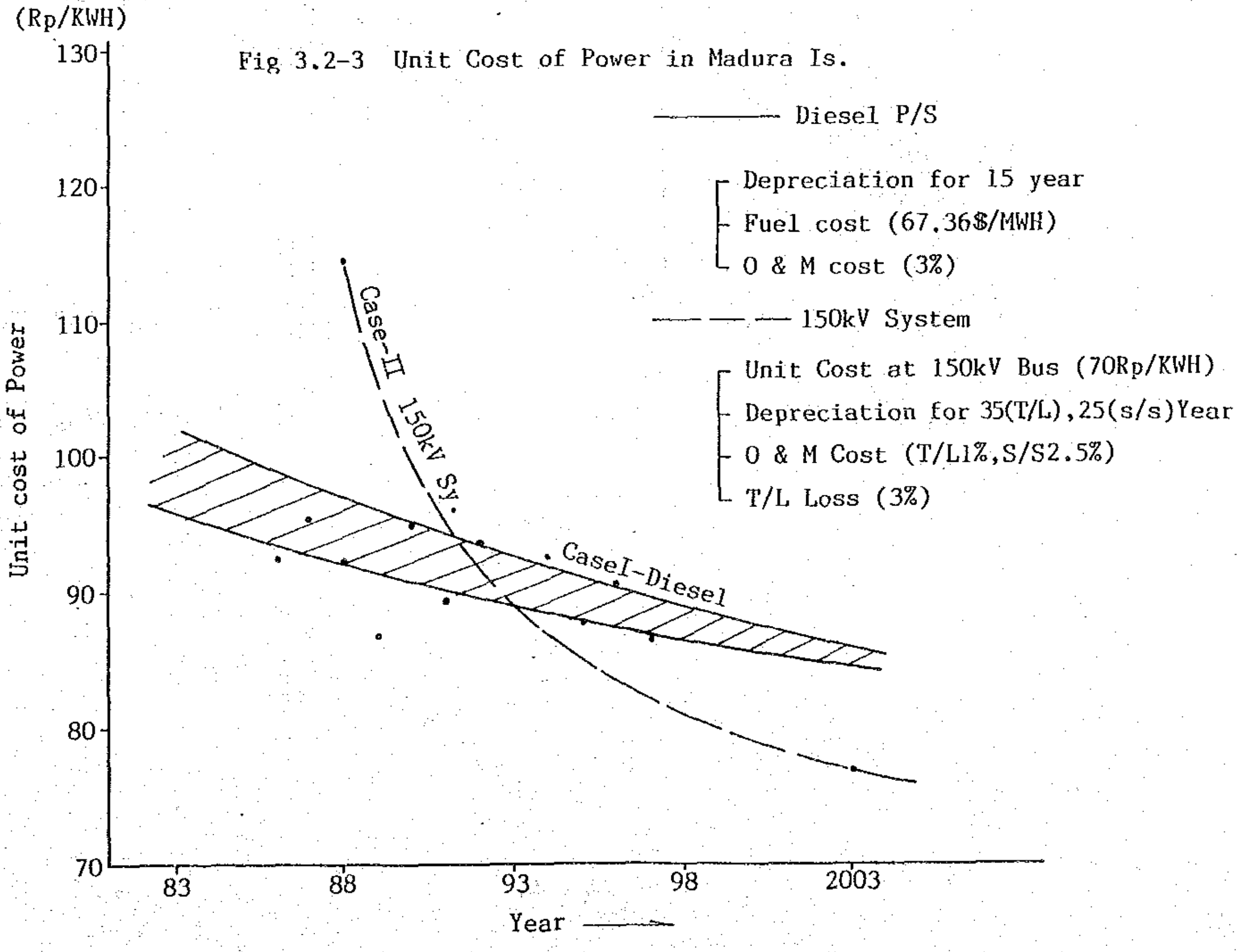
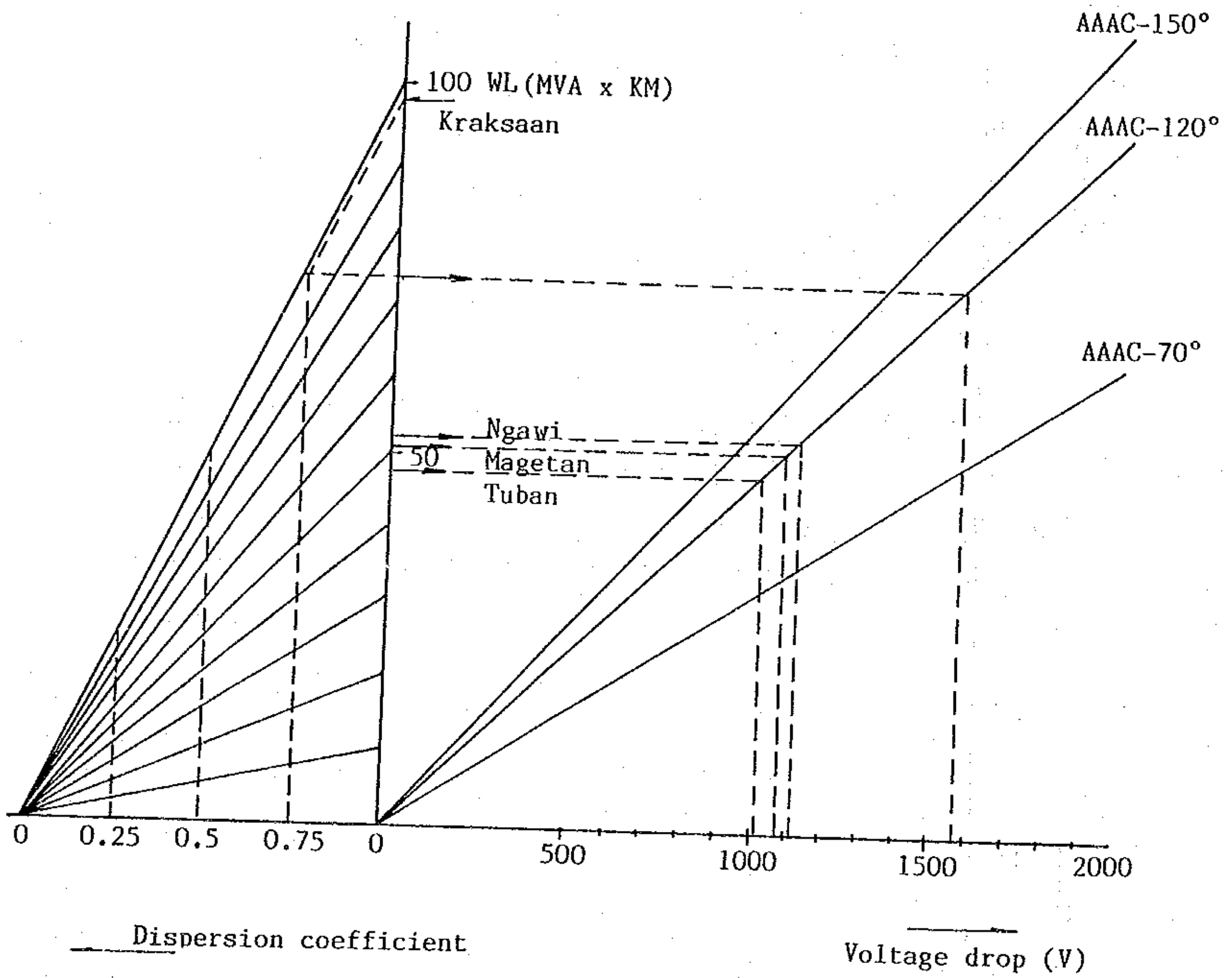


Fig 3.2-3 Unit Cost of Power in Madura Is.

Fig 3.2-4 Voltage drop of medium voltage line



3.2.2. Economic Justification

(1) Method of Economic Evaluation

In order to meet the increase of power demand in short-term period (1984/85 to 1988/89), the investments for transmission, substation and distribution facilities are not only from Indonesian governmental own money, but from IBRD, ADB and OECF. Espacially, the investments from OECF are considered for this Feasibility sutdy. The facilities are to be completed under the above various financial sources. Complication from the view-points of regions and facilities makes it difficult to distinguish the benefits of respective projects.

In this consideration, the object of this economic evaluation is meant all transmission, substation and distribution projects (except power sources and EHV projects) in East Java area to be executed in the said short-term period. Since a part of these projects is to start the commercial operation in 1983/1984, the benefit of all project was obtained by deducting the increased cost at the receiving end from the increased revenue of electric charge for a period from 1983/1984 to 1988/1989.

The economic evaluation was made by use of Internal Rate of Return (I.R.R.) calculated from the Present Worth Method, in order to evaluate the economic justification of all projects.

(2) Cost Estimation

(i) Project cost

Project cost is meant the sum of the investment and operation and maintenance cost. Investment is composed of direct cost, physical contingency and consultant fee. The project costs financed by other than OECF were also estimated from the construction unit costs used for this expansion program. Operation & Maintenance cost ratios to the construction costs were fixed at 1.0% for transmission line, 2.5% for substation and 3.0% for distribution line.

(ii) Increased energy cost at the receiving end

Energy cost at the receiving end is obtained by multiplying the increased receiving energy by the energy unit cost at the receiving end. The energy unit cost was fixed at Rp.70.0/kwh, unit cost of 150 kV bus bar very recently (April 1984) estimated by PLN. The increased receiving energy is the sum of the increased energy sales and the loss energy to be estimated by the following loss rate.

- Transmission loss rate : 3% at 150 kV bus bar
- Distribution loss rate : 10% at 20 kV bus bar

(3) Benefit Estimation

(i) The benefit of all of the projects is obtained by reducing the increased energy cost at the receiving end estimated in above Item 2.1., from the increased revenue of electric charge for all of the projects.

(ii) Unit cost of electric charge revenue was fixed at Rp.98.3/kwh, average revenue unit cost estimated by PLN in April 1984. (Exchange Rate: Rp.992/1 US$: 99.09 mills/kwh)

(iii) The increased energy sales are meant those from 1982/83. Because, a part of these projects is to start the commercial operation in 1983/1984.

(4) Estimation and Evaluation of I.R.R.

Under the above-mentioned methods and conditions, IRR calculation was made, of which results are shown in Table 3.2.-2. Namely, the Internal Rate of Return (I.R.R.) of 10% was obtained by IRR calculation for all of the projects. This rate shows the economic justification as the public utility.

(5) Sensitivity Test

The results of sensitivity test are tabulated as below:

Sensitivity Test

	Case	IRR in %
(1)	Base Case	10.0
(2)	Energy Sales : +10%	11.5
(3)	- ditto - : -10%	8.4
(4)	All Project Cost : +10%	8.5
(5)	- ditto - : -10%	11.7
(6)	Project Cost of this expansion program : +10%	9.5
(7)	- ditto - : -10%	10.5
(8)	Receiving cost : +10%	2.2
(9)	- ditto - : -10%	16.5
(10)	Revenue including connecting charge	17.7

As seen in this Table, the economic condition is most influenced by the up-down of the increased receiving energy cost. This means that the most important to level up the economic efficiency of the project is to decrease the receiving energy cost. All above cases except case (8) "Receiving cost +10%" are considered to have the economic justification for the project.

TABLE 3.2-6 ECONOMIC COSTS IN SHORT-TERM PROJECTS

UNIT:USx10^6$

	82/83	83/84	84/85	85/86	86/87	87/88	88/89
OTHER L.							
T/L	0.211	4.767	20.605	20.856	4.808	0.0	0.0
S/S	2.266	14.664	26.625	17.820	3.592	0.0	0.0
D/L	5.673	33.726	52.541	36.631	12.144	0.0	0.0
E.S.	1.709	1.829	1.752	1.218	0.007	0.0	0.0
TOTAL	9.859	54.986	101.523	76.525	20.551	0.0	0.0
JICA							
T/L	0.0	0.0	0.0	10.537	10.687	3.995	0.451
S/S	0.0	0.0	0.0	20.637	23.912	9.853	1.292
D/L	0.0	0.0	0.0	6.142	26.596	20.133	4.439
E.S.	0.0	0.0	0.463	1.712	2.276	2.451	1.384
TOTAL	0.0	0.0	0.463	39.028	63.471	36.432	7.566
G. TOTAL	9.859	54.986	101.986	115.553	84.022	36.432	7.566

COST : BASE
BENEFIT : BASE

TABLE 3.2-7 INTERNAL RATE OF RETURN IN SHORT-TERM PROJECTS

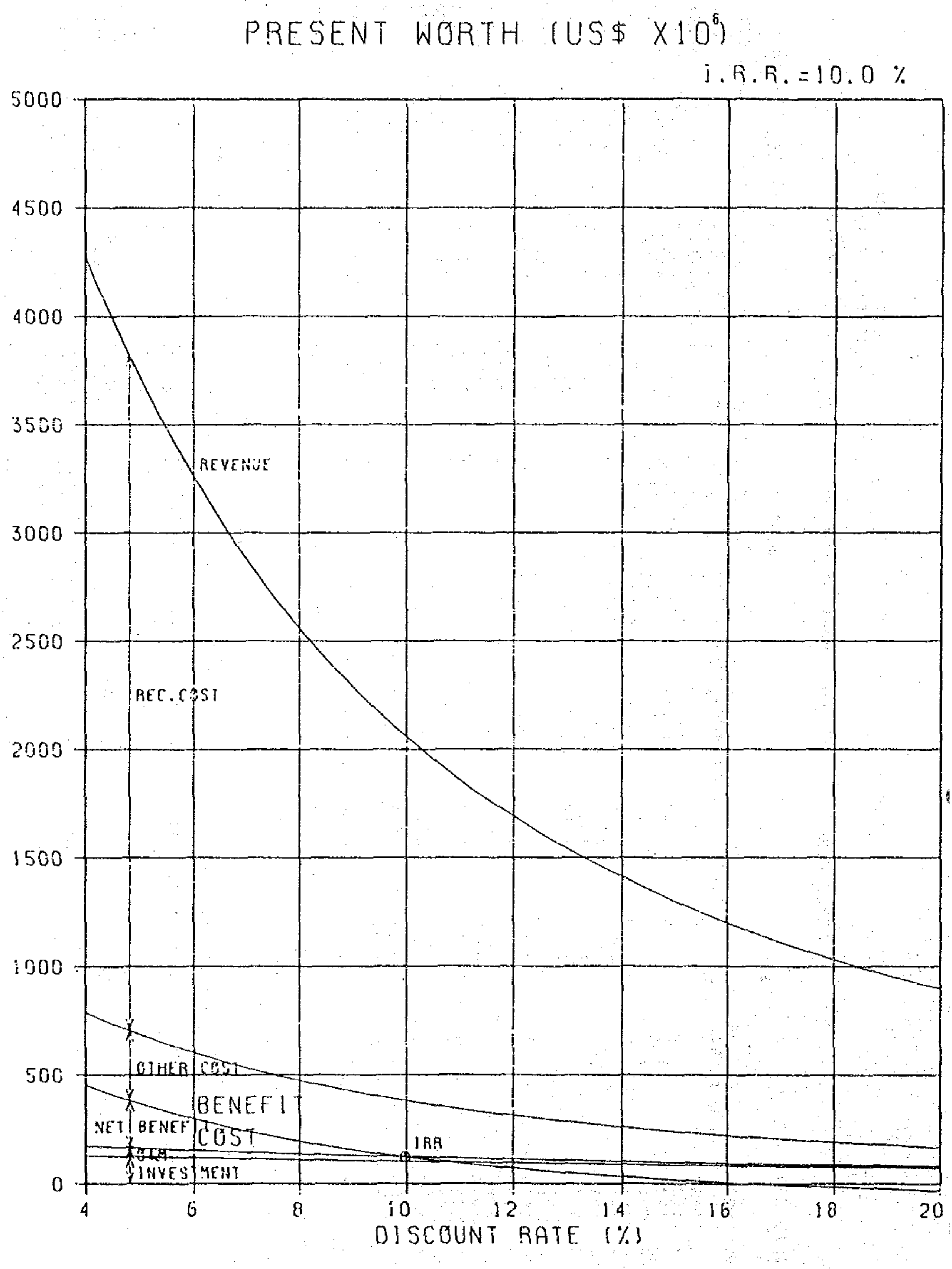
(USD X1000)

		COST			BENEFIT					PRESENT WORTH		E.I.R.R.
NO	YEAR	EXP.PROG. INVESTMENT	EXP.PROG. O&M	TOTAL	REVENUE	REC.COST	OTHER LOAN INVESTMENT	OTHER LOAN O&M	TOTAL	COST	BENEFIT	9.98 % FACTOR
1	1982	0	0	0	0	0	-9859	0	-9859	0	-9859	1.0000
2	1983	0	0	0	41618	-33946	-54986	0	-47314	0	-43020	0.9093
3	1984	463	0	463	80263	-65468	-101523	-229	-86957	383	-71891	0.8267
4	1985	39028	0	39028	123169	-100465	-76525	-1655	-55476	29338	-41702	0.7517
5	1986	63471	806	64277	170930	-139423	-20551	-4103	6853	43934	4684	0.6835
6	1987	36432	2308	38740	223943	-182664	0	-5856	35423	24076	22015	0.6215
7	1988	7566	3198	10764	282704	-230593	0	-6358	45753	6083	25854	0.5651
8	1989	0	3368	3368	282704	-230593	0	-6358	45753	1730	23508	0.5138
9	1990	0	3368	3368	282704	-230593	0	-6358	45753	1573	21375	0.4672
10	1991	0	3368	3368	282704	-230593	0	-6358	45753	1431	19435	0.4248
11	1992	0	3368	3368	282704	-230593	0	-6358	45753	1301	17671	0.3862
12	1993	0	3368	3368	282704	-230593	0	-6358	45753	1183	16068	0.3512
13	1994	0	3368	3368	282704	-230593	0	-6358	45753	1075	14610	0.3193
14	1995	0	3368	3368	282704	-230593	0	-6358	45753	978	13284	0.2903
15	1996	0	3368	3368	282704	-230593	0	-6358	45753	889	12078	0.2640
16	1997	0	3368	3368	282704	-230593	0	-6358	45753	808	10982	0.2400
17	1998	0	3368	3368	282704	-230593	0	-6358	45753	735	9986	0.2183
18	1999	0	3368	3368	282704	-230593	0	-6358	45753	668	9080	0.1984
19	2000	0	3368	3368	282704	-230593	0	-6358	45753	608	8256	0.1804
20	2001	0	3368	3368	282704	-230593	0	-6358	45753	553	7507	0.1641
1982 - 2001		146960	50096	197056	4597779	-3750268	-263444	-100855	483212	117346	69919	
2002 - 2013		0	40416	40416	3392448	-2767116	0	-76296	549036	3769	51197	
1982 - 2013		146960	90512	237472	7990227	-6517384	-263444	-177151	1032248	121115	121116	

PRESENT WORTH

	DISCOUNT RATE (%)	(4.0)	(6.0)	(8.0)	(10.0)	(12.0)	(14.0)	(16.0)
COST	EXP.PROG. INVESTMENT	125303	116014	107595	99949	92991	86648	80853
	EXP.PROG. O&M	46696	34969	26835	21046	16825	13679	11285
	TOTAL	171999	150983	134429	120994	109816	100326	92138
BENEFIT	REVENUE	4267688	3263803	2563053	2060589	1691087	1412918	1198962
	REC.COST	-3481023	-2662185	-2090604	-1680760	-1379368	-1152474	-977957
	OTHER LOANINVESTMENT	-242191	-232618	-223665	-215281	-207417	-200031	-193085
	OTHER LOAN O&M	-93526	-70998	-55288	-44037	-35776	-29569	-24805
	TOTAL	450947	298003	193496	120512	68526	30844	3115
	B/C	2.622	1.974	1.439	0.996	0.624	0.307	0.034
	B-C	278948	147020	59067	-482	-41290	-69482	-89023

FIGURE 3.2-5 PRESENT WORTH OF BENEFIT AND COST IN SHORT-TERM PROJECTS



CHAPTER 4

LONG-TERM MASTER PLAN

CHAPTER 4 LONG-TERM MASTER PLAN

4.1. Construction Cost of Mid-term and Long-term Expansion Program

4.1.1. Transmission Facilities

(1) 150 kV Transmission Line

A great increase in power demand is forecast in the Mid-term and Long-term Expansion Program. To meet this requirement, two (2) EHV receiving substations are projected. Besides, installation of 150 kV transmission lines is also planned in a radial shape from the said sub-stations, so that 150 kV transmission line with the existing 330 mm^2 ACSR twin conductor can be utilized as the required transmission facilities.

(2) Change of Earth Wire on 150 kV Transmission Line

The ground fault current is large and dividedly flowed into the ground and the earth wire, because 150 kV transmission system in East Java adopts solidly ground system. In case that the ground fault point is near the substation, the ground fault current almost runs in the earth wire, and this current is almost short-circuit current. According to the feasibility study of Surabaya City Power Distribution Project, the short-circuit current at Kiran substation in 1991 is estimated approx. 17 KA. In case of clearing by back-up protection, moment current (0.6 sec.) capacity of earth wire is only 13 KA in the existing 2 lines of earth wire 55 mm^2 AW. So, moment current carrying capacity becomes insufficient. (Ref. Fig. 4.1-1) Accordingly, in the mid and long term expansion program, 100 mm^2 AW wire is decided to be adopted as the earth wire in accordance with the capacity (25 KA $\div \frac{1}{2}$ = 12.5 KA) of a circuit breaker.

(3) The unit price of construction

The unit price of construction in short-term program was adopted in principle as that in mid-term and long-term program. However, in consideration of the construction quantity in mid and long-term program, the unit price of steel tower was changed to US$ 1,000/ton from US$ 900/ton which was adopted in short-term program. And the exchange rate of U.S. dollar to the Local Currency (Rupiah) was changed to 1,000 Rp./$ from 992 Rp./$. Table 4.1-1 shows the unit price of construction cost in mid-term and long-term expansion program.

(4) Estimated construction cost

The construction cost of transmission line facilities can be estimated multiplying the unit price as shown in Table 4.1-1 by the route length. However, in case that the route length is less than 5 km, it is adjusted to 1.1 time of the actual length for estimation (modification rate: 1.1), because of increase in the construction cost required. And in case of an incomming line to the substation near transmission line, the route length is regarded as 0.5 km of minimum length. Tht total construction cost of transmission line facilities in the mid and long-term expansion program is as shown in Table 4.1.-2.

4.1.2. Substation Facilities

(1) Substation scale and transformer unit capacity

Substation scale and transformer unit capacity were determined by the long-term study. And then, the construction of new substations and additional transformers was decided based on these scale and capacity and in such a study as mentioned in Section 2.3 "System Planning".

The transformer unit capacity is decided as below.

Transformer capacity
150kV/20kV transformer : 100MVA, 50MVA, 30MVA, 20MVA, 10MVA
70kV/20kV transformer : 50MVA, 30MVA, 20MVA, 10MVA

(2) Rated interrupting current of the circuit breaker

The rating breaking currents of the breaker are 25 KA at 150 kV, and 20 KA at 70 kV as a standard, respectively. The increase of the interrupting current is also considered in compliance with the expansion of the future system. But the breaker with the above-mentioned rated currents can be applied, because the individual system operation is considered for the system constitution with reasonable scale.

(3) Others

(a) Accompanied with the new and additional construction of substations, the removal work of existing transformers and the improvement work including duplication from single bus-bar and installation of bus protection relay may be considered for cost estimation. But, in this Report, these costs are not included for cost estimation. So, only standard construction cost for additional construction is considered. The cost of the above-mentioned improvement and removal works shall be added in accordance with the actual requirement.

It is recommended to use the physical contingency for the construction cost of those work. The cost of shunt capacitors and reactors, which are separately installed in the substations is not especially estimated in this cost estimation, because of small capacity, but is included in the unit price of transformer, itself.

(4) The unit price of construction

The unit price of construction adopted in short term program is in principle used for the unit price of construction in mid and long-term program. But the following revise was carried out in consideration of the recent trend of world price, the results of Cirata Project, proposal of IBRD Power 15, etc.

(a) The exchange rate of U.S. dollar to the Local Currency (Rupiah) is cahgned to Rp. 1,000/$.

(b) The transformer price which is the sum of Foreign Currency and Local Currency, is decreased approx. 20% lower than that estimated in short term program.

(c) The cost of telecommunicacion facilities and the guidance fee required for installation of the telecommunication facilities and the relay facilities are included in the cost of the circuit.

(d) The unit price of the substation building is 587 x 10^6 Rupiah, which is increased approx. 10% higher than that estimated in short term program.

The construction unit price decided from the above results is as shown in Tables 4.1-3, 4.1-4 and 4.1-5.

(5) The estimated construction cost

The construction quantity for the substation is as shown in Tables 4.1-6 and 4.1-7. The construction cost can be estimated by using this construction quantity and the group unit cost in Tables 4.1-3 and 4.1-4. The total construction cost for substation estimated in mid and long term plan, is as shown in Table 2.5-8. And yet, the cost related to the land acquisition is not included in the above total cost.

It is scheduled to make voltage-up to 150 kV at Sawahan substation in 1989, and also voltage-up to 500 kV at Sukolilo substation in 1994. While the Sukolilo substation can install the 500 kV facilities at the existing site (on Waru S/S side) by using Gas Insulated Switchgear. In case of voltage-up, land acquisition is required for voltage-up of 150 kV facilities. And regarding Sawahan substation, it is required to acquire a new site on north side.

4.1.3. Distribution Facilities

(1) The plan of the distribution facilities

The plan of the distribution facility was prepared on the basis of the load forecast of the low/medium voltage and number of new consumers in the mid and long-term program. The plan and the summary are explained in every facility as below.

(a) The pole transformer

The total capacity of the pole transformer in compliance with the total load of the low voltage in the middle/long term program was estimated. The capacity in the mid and long term program is tabulated in Table 4.1-9, and that in short, mid and long-term program is figured in Fig. 4.1-2. In estimating the capacity, it was planned to increase the present utilization factor (0.267) of pole transformer to 0.4 by 2003. From the 5-years estimation, the capacity which is planned during from 1994 to 1998 is maximum, and it decreases a little during from 1999 to 2003.

(b) The medium voltage line

The plan of the medium voltage line is based on the total load of the low voltage and the medium voltage. So the necessary route length at medium voltage was estimated taking by the ratio of medium voltage load to low voltage load. The basic data for and the results of this estimation are as shown in Fig. 4.1-3 and Table 4.1-10. respectively.

PLanning of underground medium voltage line was considered to the center of Surabaya city and Malang city and incoming facilities from the substation to the first pole. Based on the route length of the medium voltage line which was planned in every Cabang, the ratio of underground cable to total medium voltage line was estimated as shown in Table 4.1-12. The planned route length of the medium voltage line by the overhead/underground was as shown in Table 4.1-11.

(c) The low voltage line

In the planning of low voltage line, the route length of newly installed low voltage line per a newly installed pole transformer was fixed in this Report, because the low voltage line was planned with the pole transformer. According to the Feasibility Study of Distribution Line in East Java in Oct., 1983, the low voltage line with an average length of 1.3 km per a pole transformer is planned as shown in Table 4.1-13. The planned route length of the low voltage line in the long-term is estimated form the above planning, of which results are as shown in Table 4.1-14.

(d) The automatic section switch

The automatic section switch is installed on the long distant principal medium voltage line in order to remove the damaged section urgently. The number of installed automatic section switches in the long-term plan is estimated on the basis of the number (0.12 piece/km) of switches per newly-installed route length of the medium voltage line in near-future plan (I.B.R.D. Power 14, O.E.C.F. 4th Stage). The number of the newly-installed automatic section switches is as shown in Table 4.1-10.

(e) Service equipment

The service equipment is of 3 systems, the low voltage single phase meter system, low voltage three phase meter system and 20 kV system. These systems are very complicated each other and not clear in the kind of consumer. The cost estimation for service equipment was made on the basis of Table 4.1-15. Number of new consumers including residential, commercial and public consumers can be estimated easily. Because the number of these consumers is forecasted in the demand forecast. However, the only the electric energy is forecasted to the industry, and the number of industrial consumers is not estimated. Accordingly, annual electirc energy per consumer is estimated from historical data, it is used for the long term plan by trend method. (See Fig. 4.1-4) And the ratio of the industrial consumers in the low voltage, the medium voltage and the high voltage is subject to the present ratio (0.9053 : 0.0924 : 0.0023), and the number of the new consumers by the receiving system is estimated as shown in Table 4.1-16.

(2) The unit price of construction

The unit price which was adopted in the short term plan is applied. And yet, the unit price of the low voltage line is estimated, on the assumption that the ratio of the route length for the newly-installation to that for the extension is 0.6 : 0.4.

(3) The estimated construction cost

The construction cost by the year and by the term is estimated in consideration of the plan, the number and the unit price. The results are as shown in Table 4.1-17.

Table 4.1-1 Unit Price of T/L

Breakdown of over head T/L Unit Price in Surabaya City (1/2)

(US$/KM)

	Vg	500 kV	150 kV	150kV	150kV	150kV
	Conduct x c.c.t.	Quad Dove x 2/2	Twin 330mm² x 2/2	330mm² x 2/2	Twin 330mm² x 4/4	330mm² x 4/4
F.C.	Tower	104,330	29,046	21,012	66,806	48,307
	Conductor	125,208	40,046	19,189	80,092	38,378
	Earth Wire	4,614	4,614	4,614	4,614	4,614
	Insulator	62,790	12,627	8,345	25,254	16,690
	Others	44,541	12,950	7,974	26,515	16,198
	Total	341,483	99,283	61,134	203,281	124,187
L.C.	*Tower	86,870	36,040	26,071	82,942	59,938
	Stringing	11,579	5,146	4,117	6,433	5,146
	L.P. & R.W.	38,220	16,060	16,060	16,060	16.060
	Admi. Cost	665	354	283	443	354
	Total	137,334	57,600	46,531	105,878	81,498

Breakdown of over head T/L Unit Price Exclude Surabaya City

(US$/KM)

	Vg	150 kV				70 kV	
	Conductor x c.c.t.	330mm² x 2/2 cct			Twin330mm² x 2/2	300 MCM x 2	
	Region	* A	B	C	B	*** A (Mountain)	(Plain)
F.C.	Total	55,463	53,295	59,161	91,887	29,214	29,214
L.C.	**Tower	18,780	17,507	26,071	24,934	6,671	10,823
	Stringing	4,117	4,117	4,117	5,146	2,535	2,535
	L.P. & R.W.	13,411	13,411	16,060	13,355	** 1,411	9,943
	Admi. Cost	283	283	283	354	174	174
	Total	36,591	35,318	46,531	43,789	10,791	23,475

Note

* A : Field and Hill, Route Length 10KM

B : " 30KM

c : Residential Area Route Length 10KM

** Tower Foundation and Erection Unit Cost ($/Ton)

Region	X	Y	Z	Unit Cost
Surabaya City	0.3	0.4	0.3	1,278
Plain	0.5	0.3	0.2	1,061
Mountatin	0.8	0.2	0	654

X : Hill and Farm (Foundation Type L.M.)

Y : Paddy Field (Foundation Type H.)

Z : Pile Special Foundation

*** Land Purchase Only

Breakdown of Under Ground Cable Unit Price 150kV single Core O.F. Cable(800mm^{2}cu) (*US$x10^3/KM)

Item \ No. of c.c.t. / Route Length	1 c.c.t.		2 c.c.t.	
	3KM	5KM	3KM	5KM
150kV Single core O.F. cable(800mm^{2}cu)	209	209	418	418
Joint Accessory	12	12	24	24
Terminal	26	15	52	31
Control and Telecom. Cable	11	11	22	22
Testing Equipm. and Appliance	9	7	10	8
Guidance Fee	18	13	22	17
Jointer Fee	22	18	32	26
Others	15	14	29	28
Total	322	299	609	574

Note

* F.C. Only

Table 4.1-2 Construction Cost of Transmission Line

(1/2)

No.	Year	From - To	Vg	C.C.T.	Route L.	Conductor	Unit Price (US$x10³) F.C.	Unit Price (US$x10³) L.C.	Construction Cost (US$x10³) F.C.	Construction Cost (US$x10³) L.C.	Construction Cost (US$x10³) F.C.+L.C.	Remark
1	1989	(Probolinggo / Jember) - Tanggul 2π Incomer	150	4	2.0	330mm²	124.187 x 1.1	81.498	273	163	436	
2	"	Babat - Tuban 2nd C.C.T.	150	1	30.9	330mm²	16.820	3.731	520	115	635	
3	"	(Jember / Banyuwangi) - Genteng 2π Incomer	150	4	5.0	330mm²	124.187	81.498	621	407	1,028	
4	"	Tandes - Sawahan	150	2	4.0	Twin 330mm²	99.283 x 1.1	57.600	437	230	667	
5	"	Perak - Sukolilo 1st Stage (To Ujung)	150	2	2.6	330mm²	124.187 x 1.1	81.498	355	212	567	With 70kV 2 c.c.t.
6	"	(Gresik / Waru) - Karang Pilang 2π Incomer	150	4	2.6	Twin 330mm²	203.281 x 1.1	105.878	581	275	856	
7	"	Tulungagung - Trenggalek	70	2	25.0	300 MCM	29.214	10.791	730	270	1,000	
8	"	Wonorejo - Tulungagung	70	2	15.0	300 MCM	29.214	10.791	438	162	600	
9	"	Paiton - Sitobondo 2nd C.C.T.	150	1	40.0	Twin 330mm²	30.841	4.665	1,234	187	1,421	
10	"	Situbondo - Jember 2nd C.C.T.	150	1	81.0	330mm²	16.820	3.731	1,362	302	1,664	
11	"	Jombang - Incomer	70	2	10.0	300 MCM	29.214	23.475	292	235	527	
12	"	Kesamben - Wlingi	70	2	14.0	300 MCM	29.214	10.791	409	151	560	
13	1990	Kepanjen s/s - Kebonagung	70	2	17.5	300 MCM	29.214	23.475	511	411	922	
14	"	(Waru / Sukolilo) - Semanbung 2π Incomer	150	4	2.3	Twin 330mm²	203.281 x 1.1	105.878	514	244	758	
15	"	Kebonagung - Polehan	150	2	5.0	330mm²	55.463	36.591	277	183	460	
16	1991	Metro - Kepanjen s/s	70	2	5.0	300 MCM	29.214	10.791	146	54	200	
17	1992	(Gresik / Karang Pilang) - Benowo π Incomer	150	2	3.7	Twin 330mm²	99.283 x 1.1	57.600	404	213	617	
18	"	(Bangil / Kebonagung) - Lawang π Incomer	150	2	2.0	330mm²	55.463 x 1.1	36.591	122	73	195	
19	1993	(Krian / Babatan) - Driyorejo π Incomer	150	2	1.5	330mm²	59.161 x 1.1	46.531	98	70	168	
20	"	(Waru / Bangil) - Sidoarjo 2π Incomer	150	4	2.0	330mm²	124.187 x 1.1	81.498	273	163	436	
		Total							9,597	4,120	13,717	