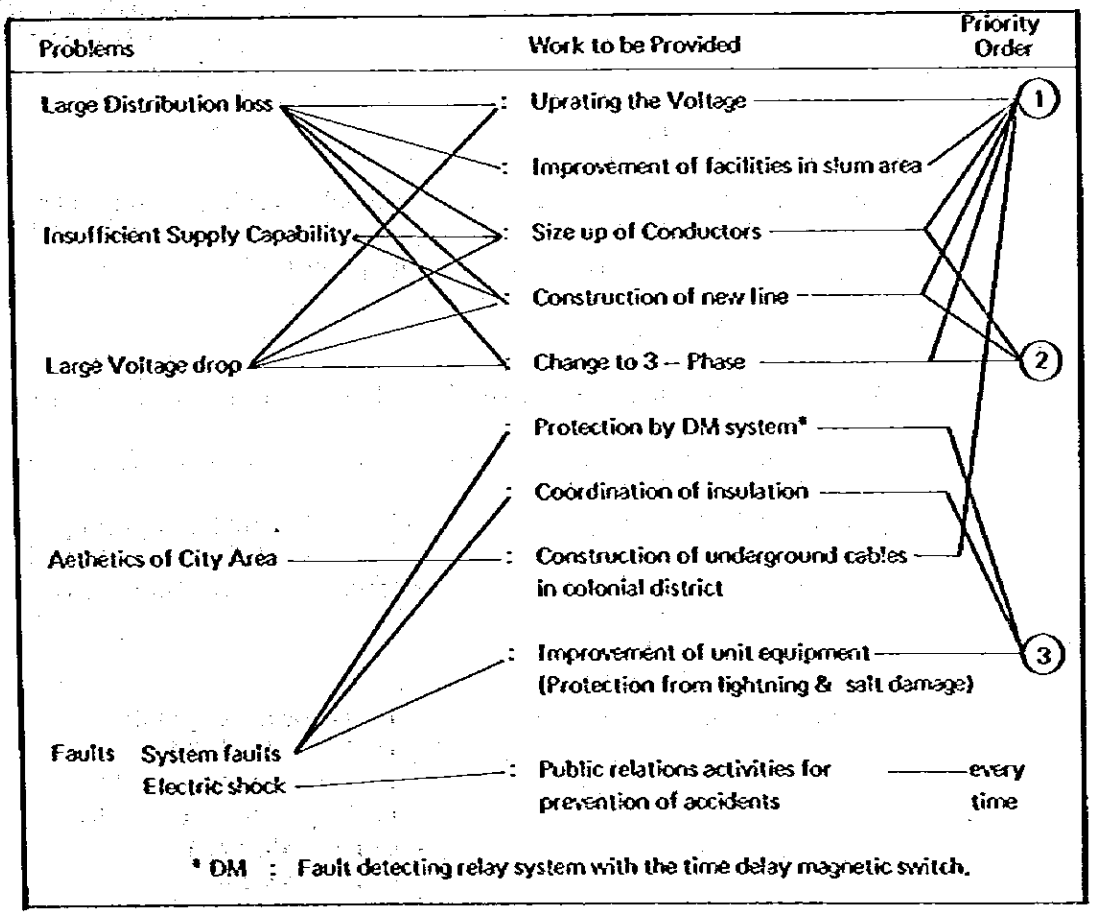
3) Distribution Line (Vehicles and Tools Included)

As already mentioned in the section dealing with the present state and problems of distribution facilities, the state of distribution system is at a deadlock and its improvement is urgently required for stable power supply.

Works to be done include for example, the increase of supply capabilities, measures against stealing of electricity, minimization of transmission loss, maintenance of proper voltage and aesthetics of city area and there are other countless requirements.

In carrying out construction work, priority order of the work should be determined according to the amount of funds available and the construction schedule.

Fig. 5 - 4 Chart of Priority Order



The work in the 1st stage construction will start with facilities of higher priority.

a) Construction of underground distribution lines

The colonial district is a popular sightseeing area in Santo Domingo City. For amenity of the city and safety of the public, distribution lines in this district should be laid underground and the rated voltage of distribution lines will be uprated at the same time.

o Total area for construction of underground cables	Approx 1 km²
o Number of underground feeders	4
o Total length of H.V. cables	7.6 km
o Construction method	Conduit system (max. Four Conduits)
o Cable	Cross-linked Polyethylene insulated cable CU 350 MCM, for 15 kV
o Number of manholes	37

Low voltage lines will also be laid underground as a rule but overhead lines will be used for narrow streets where excavation is difficult.

b) Uprating the Voltage

As previously discussed, the 4.16 kV feeders present many problems such as large distribution loss and voltage drop. For this reason, the uprating was considered for 8 existing feeders. Working feeders subject to the uprating of rated voltage are the following as other feeders are scheduled to be converted to underground cables.

o Working feeders – 6 feeders ——
- Timbeque SS. Capotillo
- Timbeque SS. Vill Francisca
- Timbeque SS. Industrial Planta
- Timbeque SS. Part of Independecia
- La Feria SS. No. 1
- La Feria SS. No. 5

- Number of pole transformers to be replaced : 700 units
- Method of uprating

  Since no consumers receive power directly from high voltage in the area, the work of uprating can be accomplished without difficulty. However, it is not possible, as a matter of fact, to replace some 700 units of pole transformer on the day scheduled for the uprating work. It is necessary, therefore, to purchase transformers of dual ratings (transformers with voltage to ground of 2.4 kV and 7.2 kV) and complete the replacement of existing transformers with these transformers by the day of chang-over. The system may be operated at 4.2 kV until the day of change-over when all the taps may be changed all at once. In the case of a feeder which can be interconnected with other feeders, change-over may be accomplished from the load side of the line step by step (taps may be changed one after another from the load side of the line).

c) Construction of New High Voltage Distribution Lines

New feeders will be provided in conjunction with the construction of an additional substation and the increase of the number of banks in the existing substations.

i) Line capacity

The type of conductor to be used at the drawing-out of substation will be 600 MCM Cu cable for underground lines and 266 MCM ACSR conductor for overhead lines. These conductors have a capacity of 8.9 MW for normal operation but can carry up to 10.7 MW (120 % overload rating) in an emergency. However, the design capacity shall be 7.5 MW for normal operation to maintain a reserve capacity in case of a fault in other interconnecting lines. Accordingly, the number of new feeders to be provided for each additional bank of 28 MVA will be three.

ii) Conductor

Cu is about three times heavier than AL in weight but the conductivity of the latter is only 60 % of the former. When the current price per ton is taken into consideration, the AL conductor can be laid twice the length of the Cu conductor at the same cost. For this reason, ACSR bare conductors will be used for H.V. distribution lines and conductors 4/0 or above will be used for trunk lines.

iii)	Number of new feeders and additional feeders	27
iv)	Total length of new distribution lines:	73 km
v)	Conductor	ACSR 4/0 or ACSR 266 MCM

d) Size up of Conductors and Change to Three–phase

Very small size conductors are used even for trunk lines in many cases. Size up of conductors is designed for improvement of transmission loss rate and prevention of voltage drop and also for providing reserve capacity for load transfer in case of a system fault.

Since the lst stage construction is scheduled for a large work quantity such as the construction of underground cables and the work for the increase of rated voltage, the work for size up of conductors and change to three–phase will be allocated to the 1st stage and 2nd stage construction, with approximately 50 % of the scheduled work quantity to be completed in the 1st stage.

- Total length of trunk lines for size up: 100 km
- Total length of lines to be changed to three–phase; 70 km
- Conductors to be used: ACSR 4/0 or
ACSR 266 MCM

e) Improvement of Distribution Lines in Slum Area

As a rule, new distribution lines will be provided through extension of high and low voltage lines to this area. Since a large work quantity is involved, this

work will be allocated to the 1st and 2nd stage construction, with approximately 50 % of the scheduled work to be completed in the 1st stage.

	1st stage	Total quantity
No. of poles to be provided	2,300	4,600
H.V. lines to be extended (km)	20	40
L.V. lines to be extended (km)	115	230
No. of service entrances (place)	25,000	50,000
No. of W.H. meter (ea)	25,000	50,000

f) Improvement of Low Voltage Distribution Lines

Since the low voltage distribution lines other than those in the slum area also use small size conductors and are considered to have a large transmission loss, they should also be improved under the project. Because of a large work quantity involved, the improvement work will be allocated to the 1st and 2nd stage construction, with the following to be accomplished in the 1st stage.

- Total length of L.V. lines to be provided: 100 km
- Conductor to be used: Outdoor, weather proof wire .....OW (Vinyl insulated)

g) Tools and Instruments

Since the construction and improvement works mentioned above involve large work quantities and a long period of time, efforts should be made to save man-power and improve work efficiency through such means as mechanization of work to the extent possible. For this purpose, the purchase of compression tools, vehicles of various types and test equipment was considered. (For details, refer to the attachment at the last portion of the report).

Fig 5-12

Under Ground Distribution Line Route map

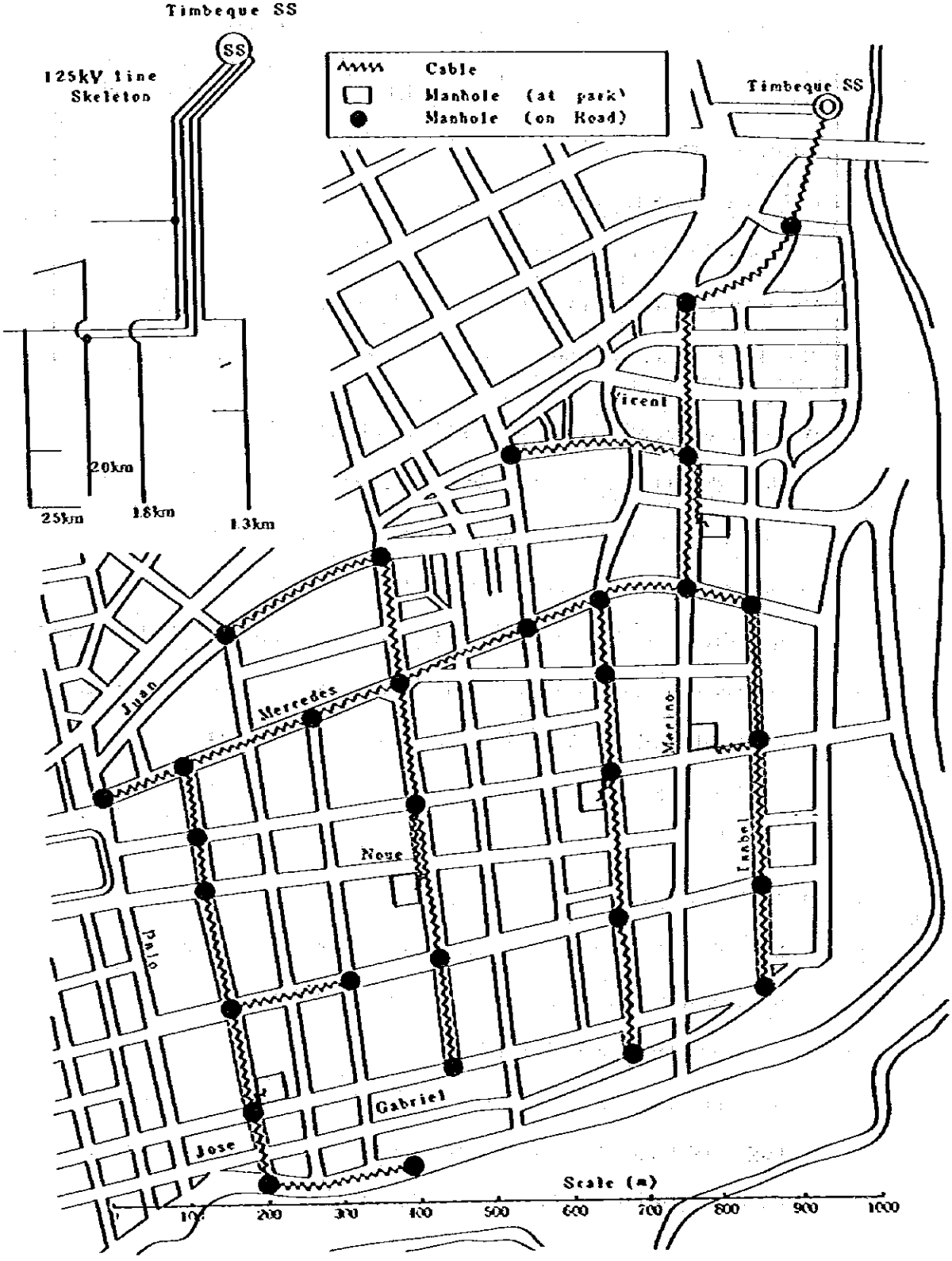
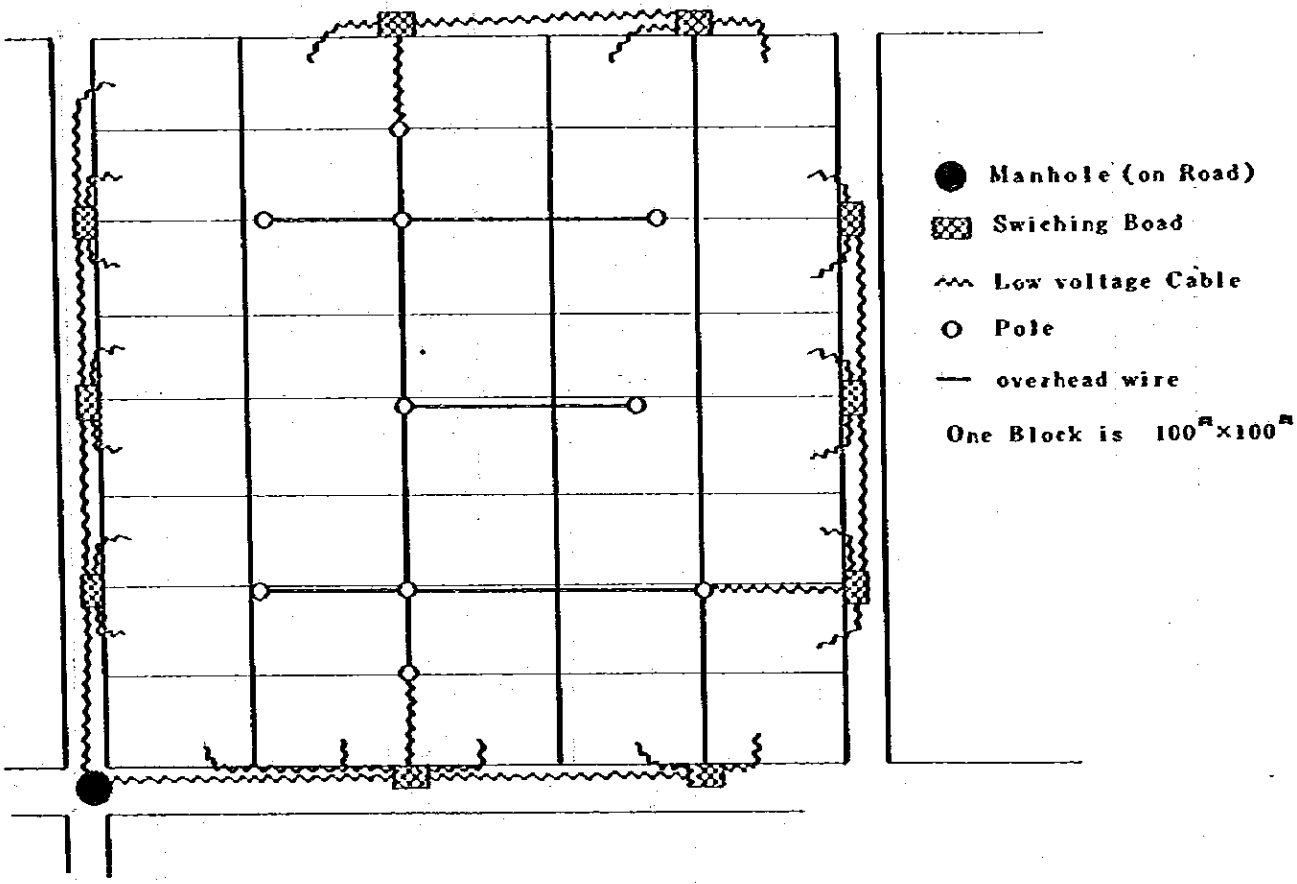


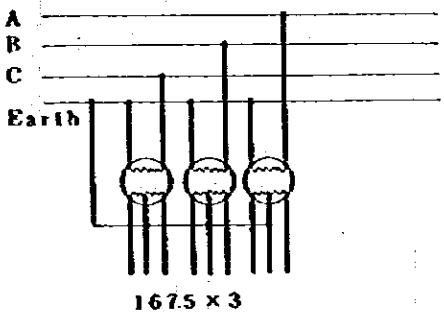
Fig 5－13

Low voltage cable model



Connection of Distribution Transformer

Lighting Load



Power Load

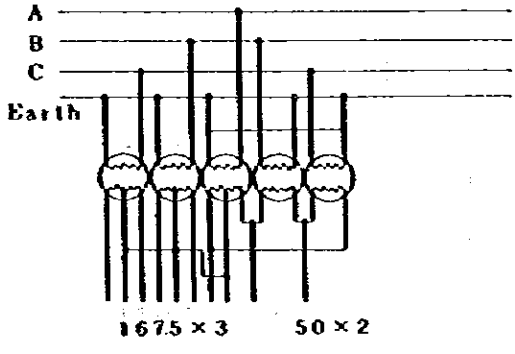
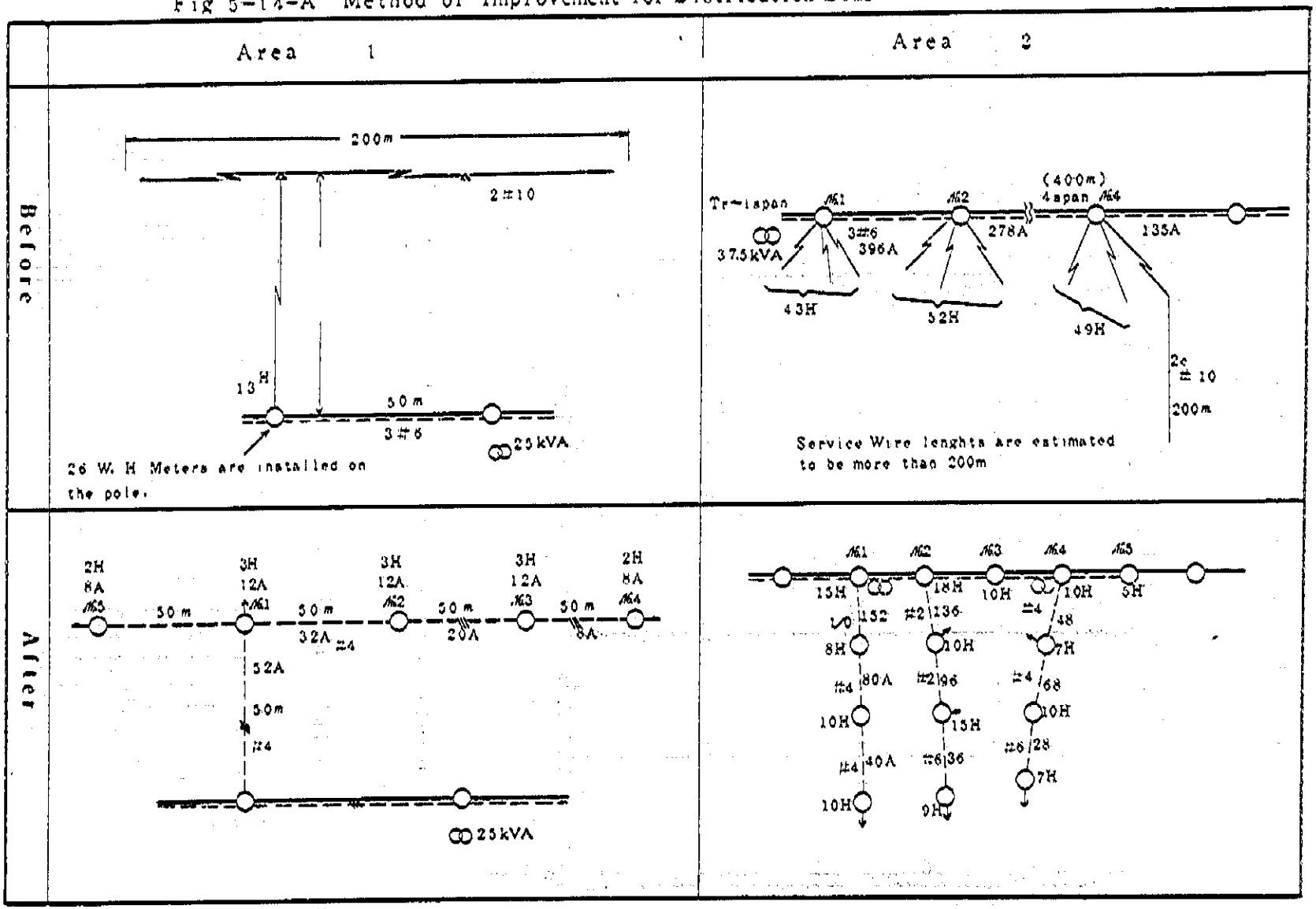


Fig 5-14-A Method of Improvement for Distribution Line



remark H : number of House

Fig 5 – 14 – B

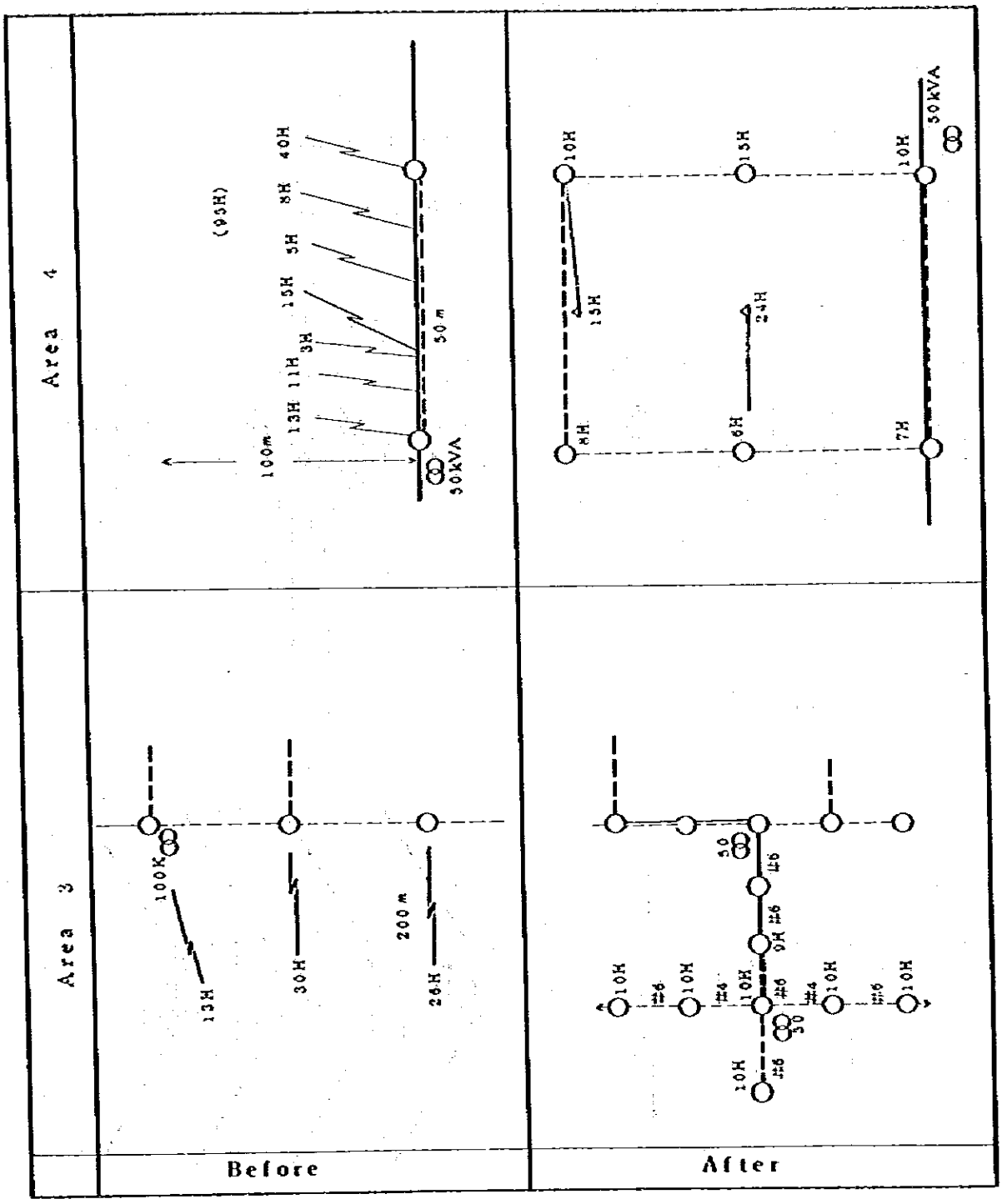
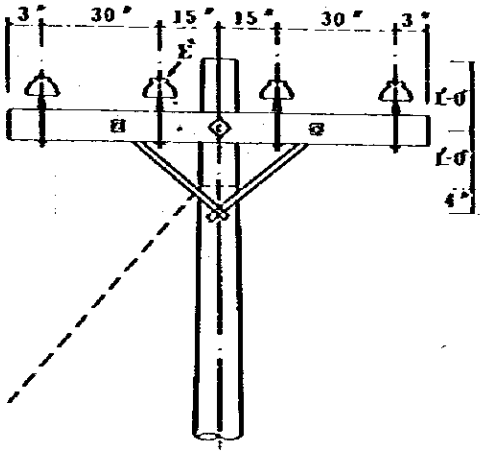

Area 4
Area 3
Before
After
(95H)
40H
8H
5H
15H
3H
13H 11H
100m
50m
50kVA
10H
15H
10H
50kVA
13H
24H
8H
6H
7H
100K
13H
30H
200m
26H
50
#6
9H
#6
10H
#6
10H
#4
10H
#6
#4
10H
#6
10H
50
#6
10H

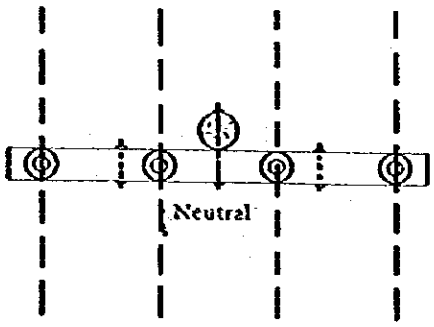
Fig 5 – 15 Details of Pole Dimension Diagram

($7.2/12.5^{kV}$, Primary 3-Phase)

Cross-arm Structure
Single Primary Support
at Tangent and 0° to 5° Angle

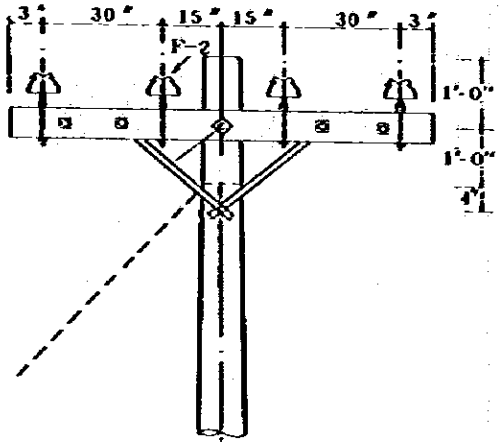
Type : F-1





Cross-arm Structure
Double Primary Support
at 6° to 20° Angle

Type : F-2



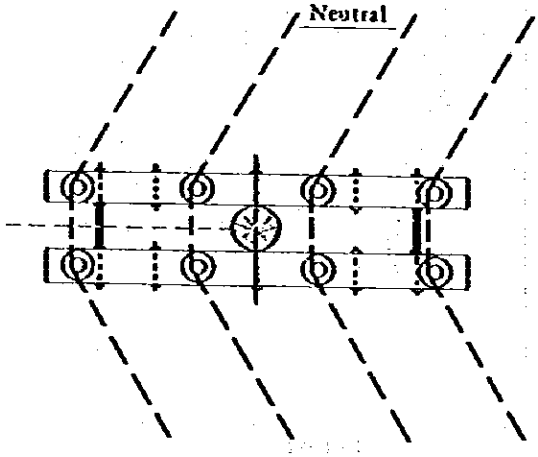


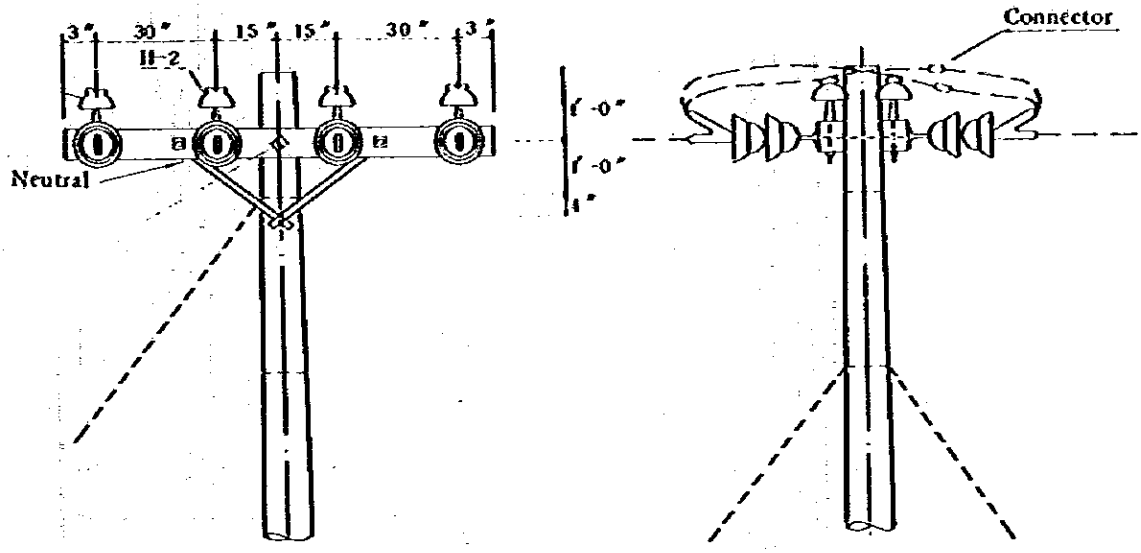
Fig 5 – 16 Details of Pole Dimension Diagram

($7.2/12.5^{kV}$, Primary 3-Phase)

Cross-arm Structure

Terminal Double Horizontal Support

Type : F-7



($120/240^{V}$, Secondary Single Phase 3-Wires)

Simple Support at Tangent

Type : S-1

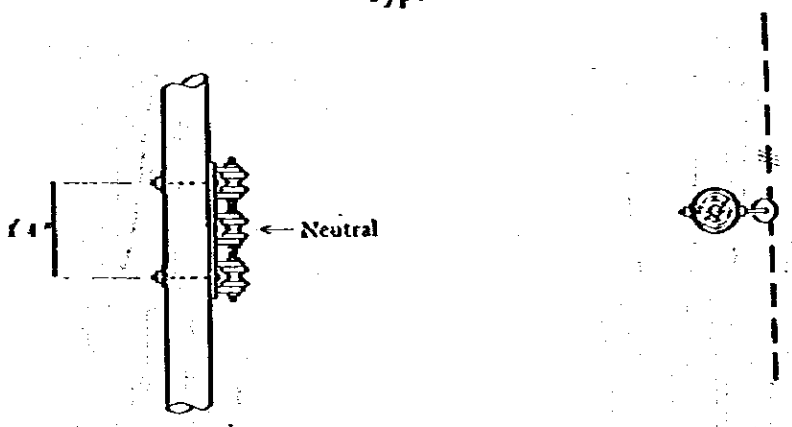
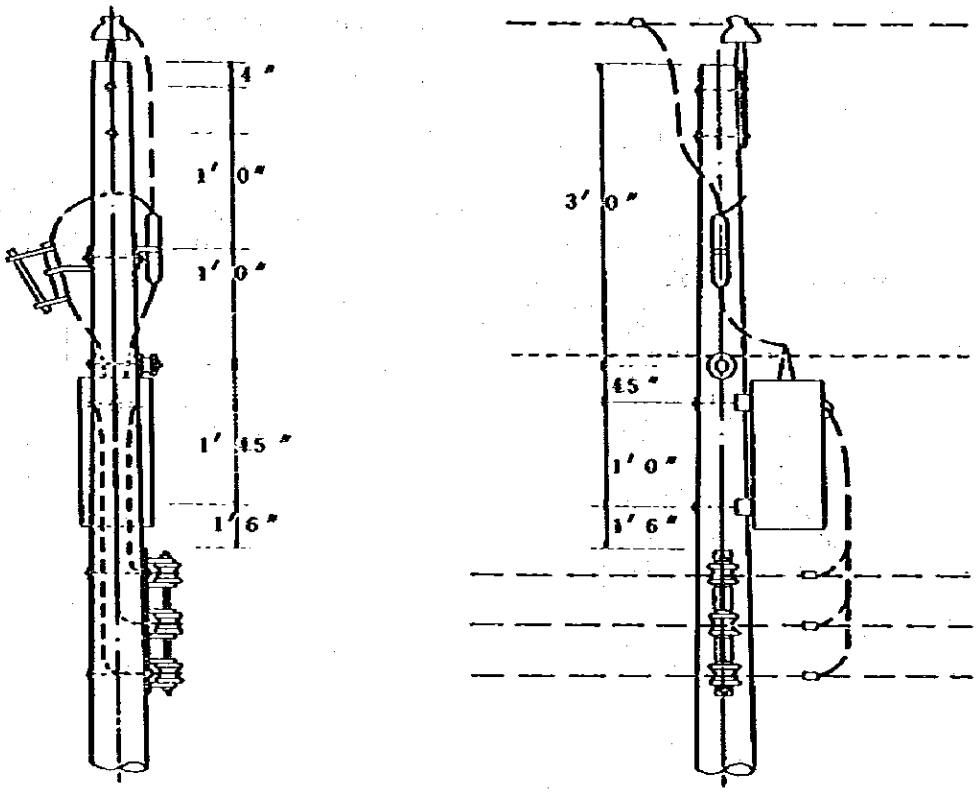


Fig 5–17 Details of Pole Dimension Diagram

$12.5/7.2$kV – $120/240$V,
Single Phase Transformer
Type : DT-1



$12.5/7.2$kV – $120/240$V
3-Phase Transformer

Type : DT-3

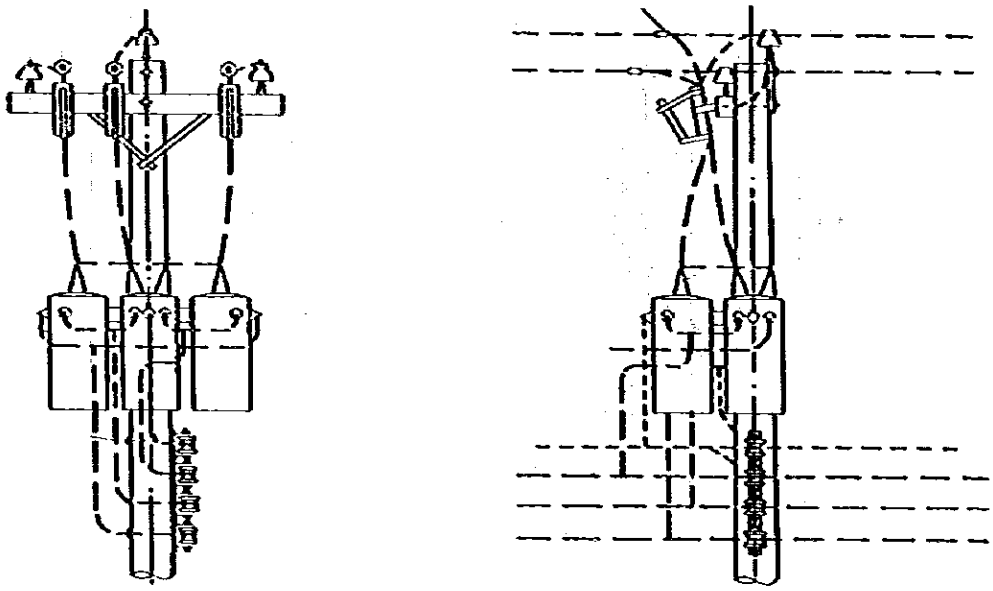
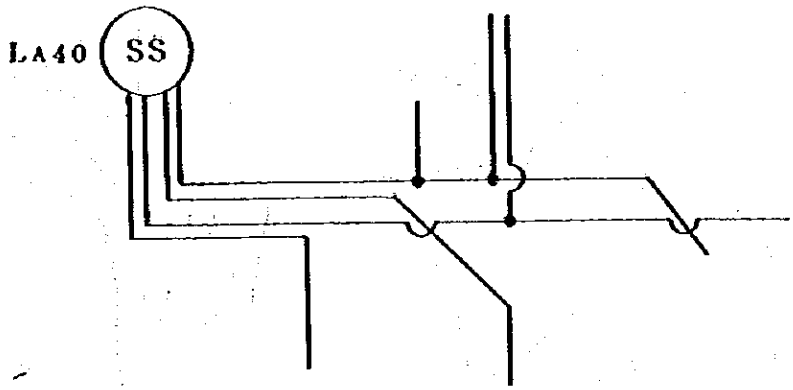


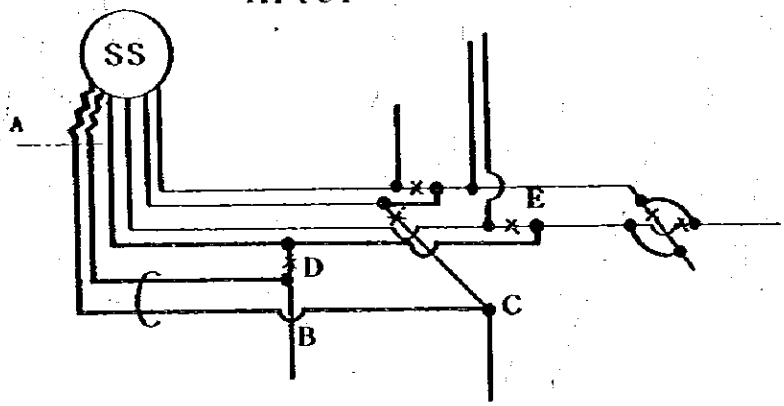
Table 5 – 5 –(1) Estimation of Construction Cost for Feeder

Case 1

Before



After

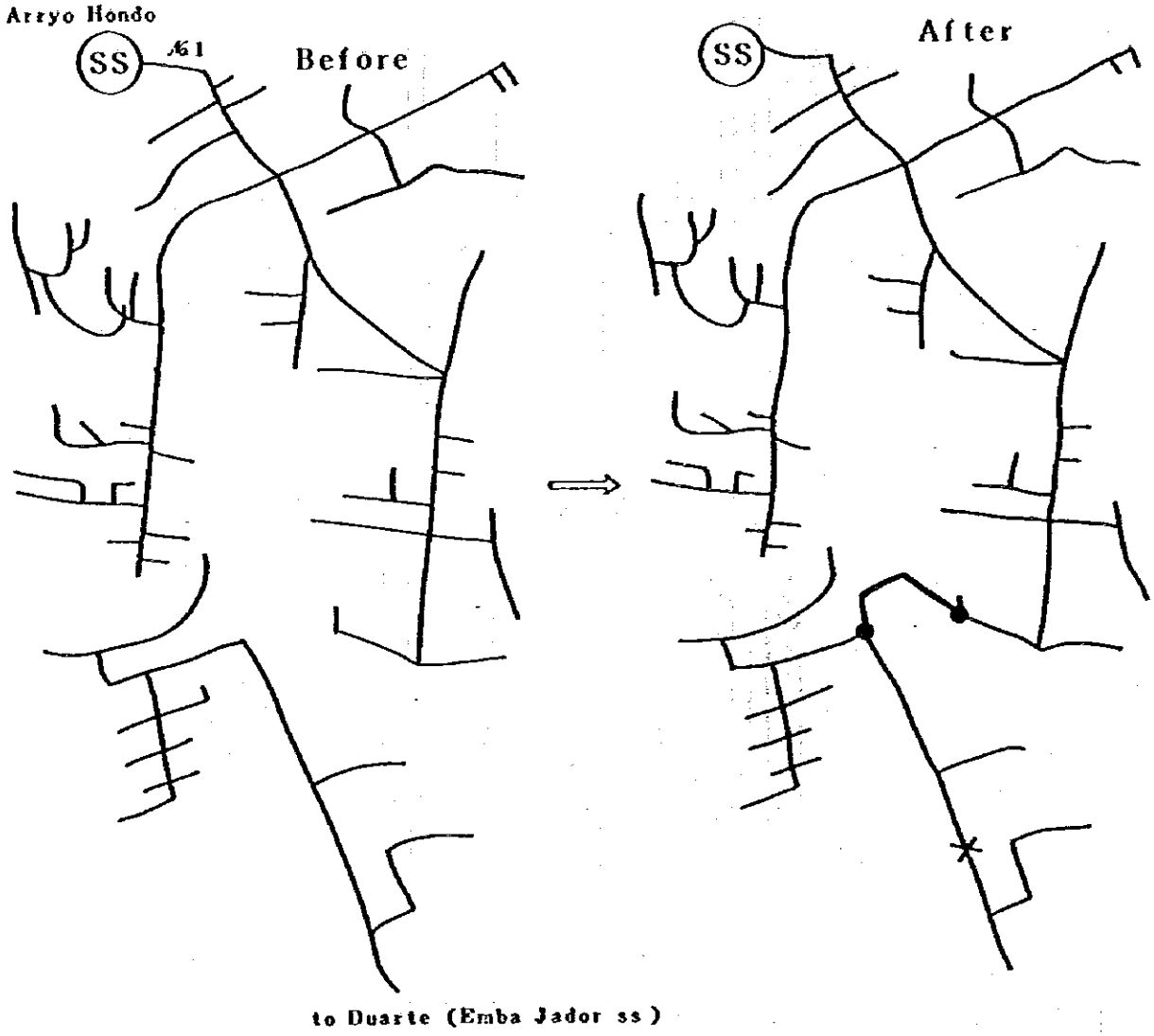


Unit : 10^3 ¥

Section	Length Km	Construction work	Construction New. H.V.D. line	Conductor Size up	Under built	Outgoing Cable	Total
SS–A	02 x 2	under ground	–	–	–	30,316	30,316
A–B	0.6 x 2	ACSR 266MCM 3φ4W 2cct	8,128	–	–	–	8,128
B–C	0.8	ACSR 266MCM 3φ4W 1cct	6,275	–	–	–	6,275
D–E	0.8	ACSR 266MCM 3φ4W 1cct	–	–	4,562	–	4,562
SS–D	0.6	ACSR 266MCM 3φ4W	–	2,747	–	–	2,747
Total	3.8	–	14,403	2,747	4,562	30,316	52,028

Table 5 – 5 –(2) Estimation of Construction Cost for Feeder

Case 2

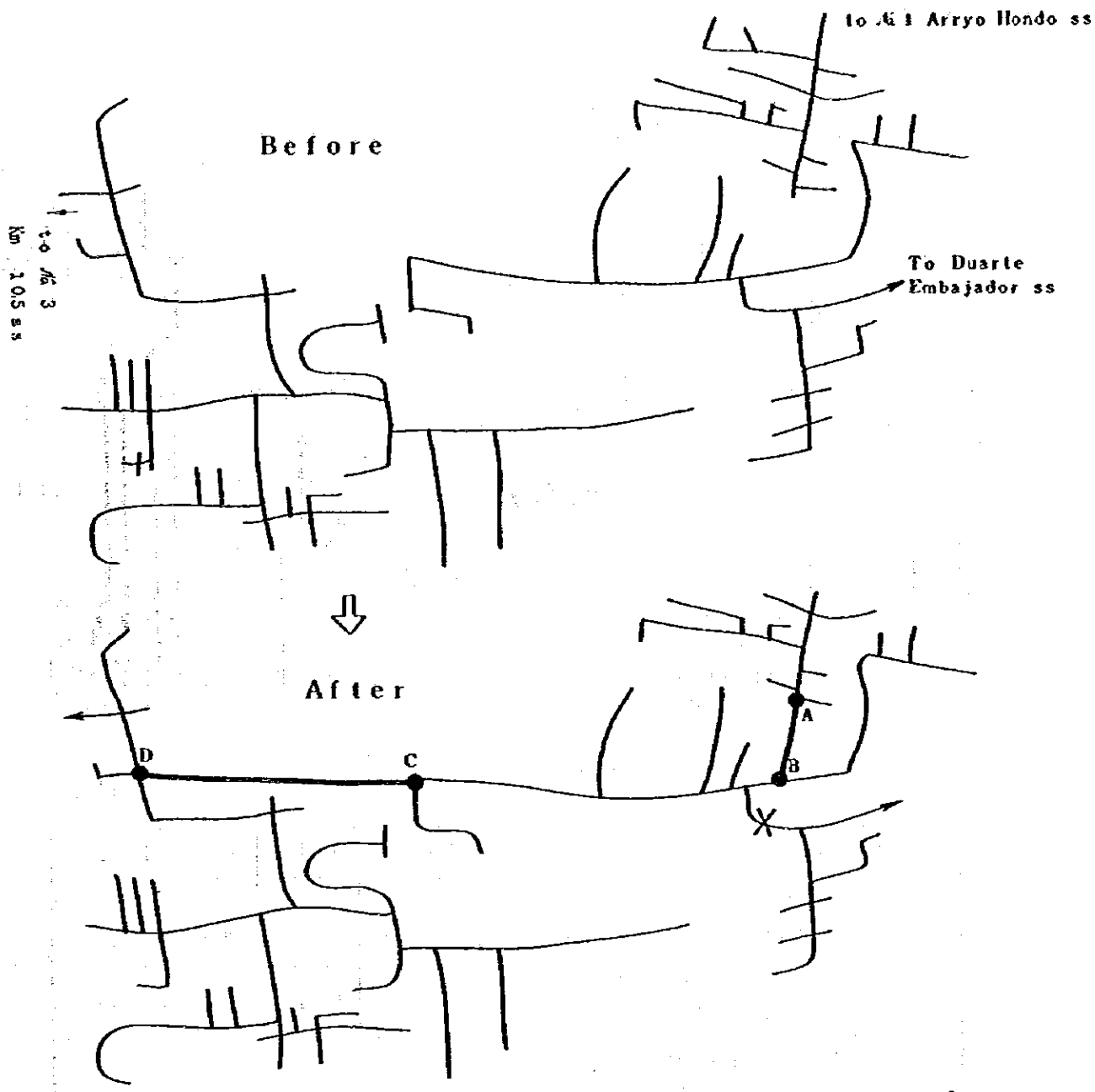


Unit : 10^3 ¥

Section	Length km	Construction work	Construction New. H.V.D. line	Conductor size up	Under built	Outgoing Cable	Total
A–B	0.6	ACSR 2/0 3φ4W 1cct	2,973	–	–	–	2,973

Table 5 – 5 –(3) Estimation of Construction Cost for Feeder

Case 3

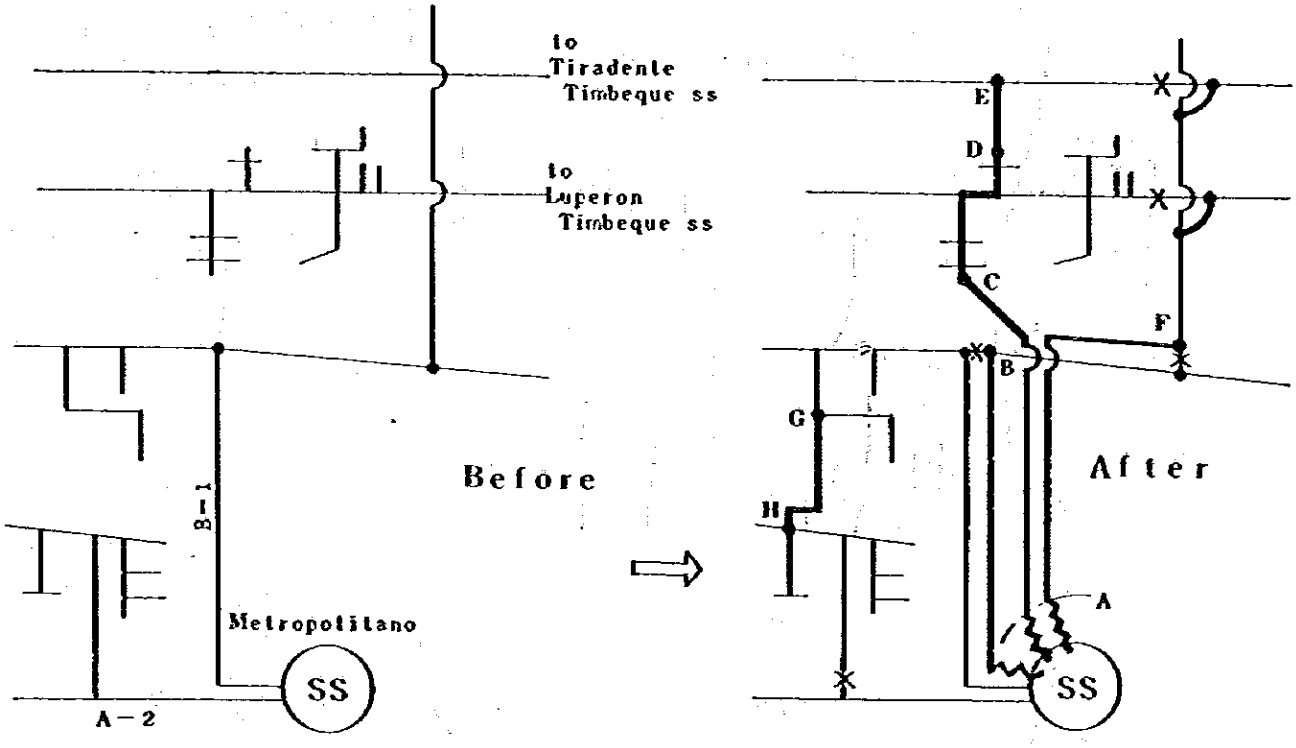


Unit : 10^3 ¥

Section	Length km	Construction work	Construction New. H.V.D. line	Conductor Size up	Under Construction	Outgoing Cable	Total
A–B	0.2	ACSR 2/0 3φ4W 1cct	991	–	–	–	991
C–D	1.0	ACSR 4/0 3φ4W 1cct	6,662	–	–	–	6,662
Total	1.2	–	7,653	–	–	–	7,653

Table 5 - 5 -(4) Estimation of Construction cost for Feeder

Case 4

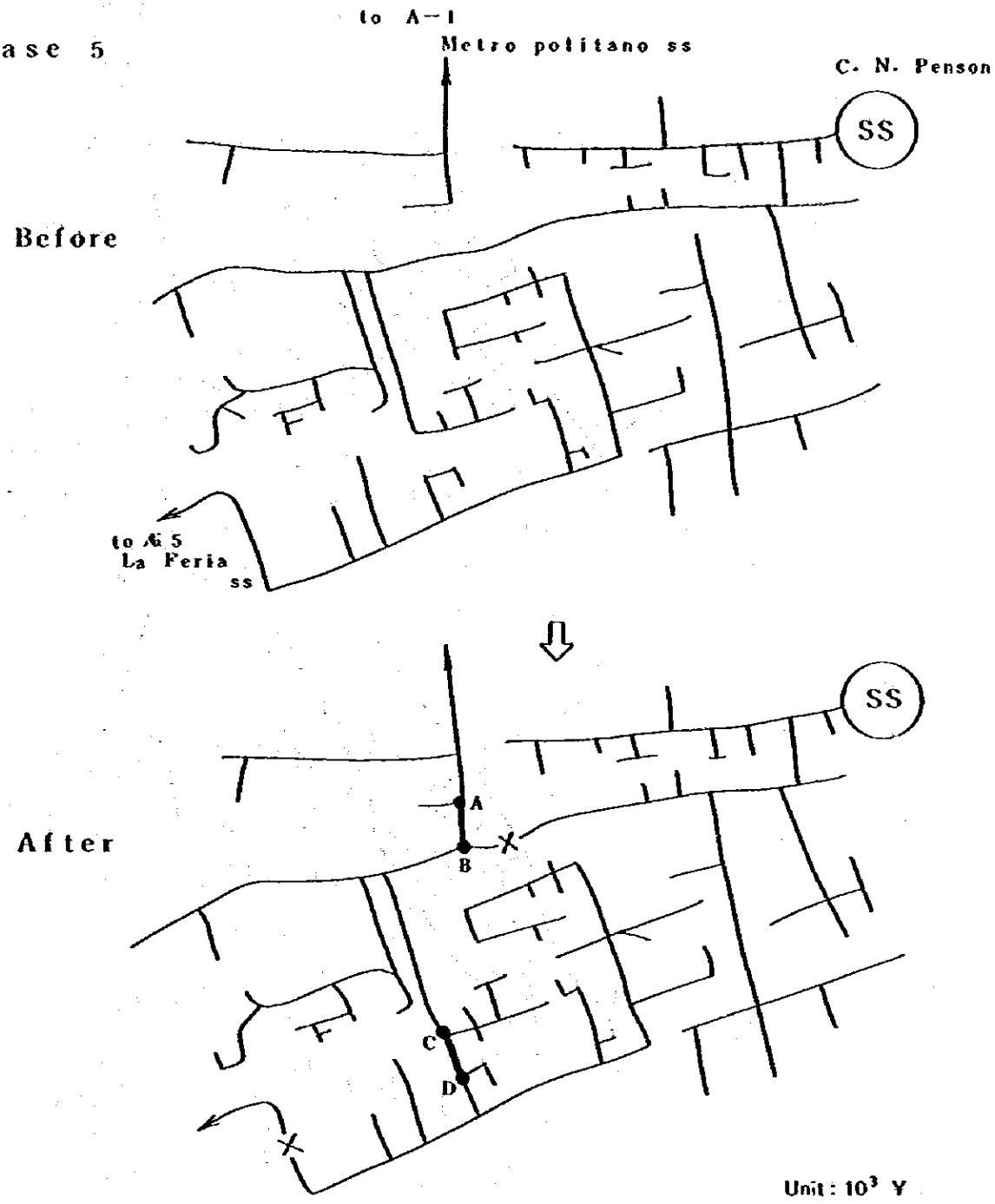


Unit : 10^3 ¥

Section	Length km	Construction work	Construction New. H.V.D. line	Conductor Size up	Under built	Outgoing Cable	Total
SS–A	0.2 x 3	under ground	–	–	–	45,474	45,474
A–B	1.0	ACSR 266MCM 3φ4W 1cct	–	–	5,702	–	5,702
A–B	1.0 x 2	ACSR 266MCM 3φ4W 2cct	13,546	–	–	–	13,546
B–C D–E G–H	0.2 0.1 0.25 (0.55)	ACSR 4/0	3,664	–	–	–	3,164
B–F	0.7	ACSR 4/0 3φ4W 1cct	–	–	3,164	–	3,164
C–D	0.7	ACSR 4/0 3φ4W 1cct	–	2,377	–	–	2,377
Total	5.6	–	17,210	2,377	8,866	45,474	73,927

Table 5 – 5 –(5) Estimation of Construction Cost for Feeder

Case 5



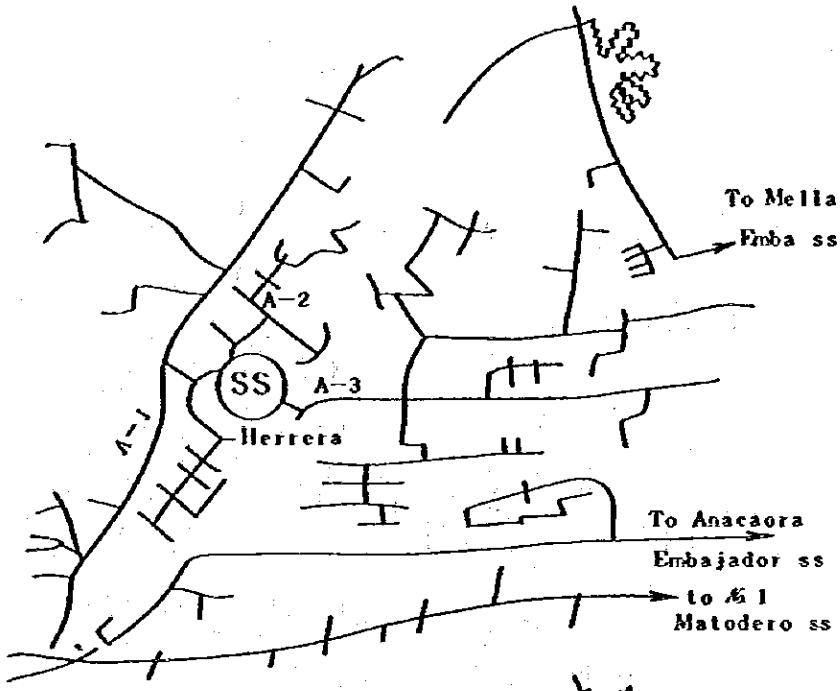
Unit : 10^3 ¥

Section	Length km	Construction work	Construction New H.V.D line	Conductor Size up	Under Construction	Outgoing Cable	Total
A–B	0.1	ACSR 2/0 3φ4W 1cct	496	–	–	–	496
C–D	0.2	ACSR 2/0 3φ4W 1cct	991	–	–	–	991
Total	0.3	–	1,487	–	–	–	1,487

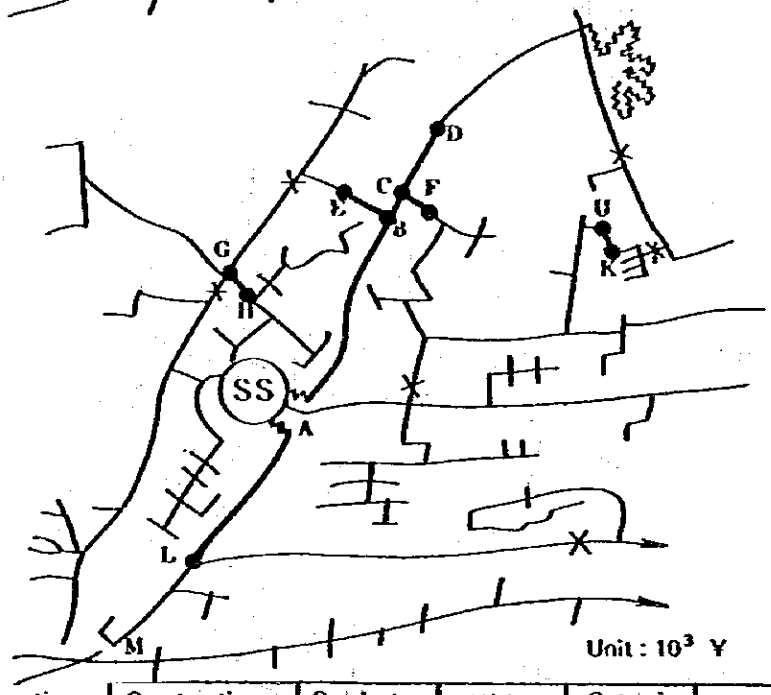
Table 5 – 5 –(6) . Estimation of Construction Cost for Feedr

Case 6

Before



After



Unit : 10^3 ¥

Section	Length km	Construction work	Construction New. H.V.D. line	Conductor size up	Under built	Out going cable	Total
SS–A	02 x 2	under ground	–	–	–	30,316	30,316
A–L	1.25	ACSR 266MCM	12,305	–	–	–	12,305
L–M	1.2	"	–	5,494	–	–	5,494
A–D	3.2	"	25,100	–	–	–	25,100
G–H	0.2	ACSR 2/0	991	–	–	–	991
B–E	0.4	"	1,982	–	–	–	1,982
C–F	0.1	ACSR 266MCM	984	–	–	–	984
J–K	0.1	ACSR 2/0	496	–	–	–	496
Total	6.9	–	41,858	5,494	–	30,316	77,668

5 - 4 2nd Stage Construction Plan

1) Transmission Line and Substation Facility

In succession to the 1st stage construction, installation of additional transformers (by relocation) was considered as a measure to cope with the overload of main transformers in existing substations with the increase of demand and construction of two new substations (Los. Prados SS and Ens. Espaillat SS) was planned to stabilize power supply in heavy-loaded areas.

Also, the introduction of 138 kV system into the city and the construction of a new 138 kV substation were considered to meet the increase of load in the central and western districts of the city and also to augment the existing 69 kV system.

For transmission lines, the two circuits between Timbeque and Arroyo Hondo use 1/0 Cu and 2/0 Cu conductors in parts and there will be a shortage of transmission capacity in this section.

For this reason, these conductors must be replaced with 240 mm² ACSR conductors.

For the 138 kV transmission line to be introduced into the city, two circuit design was planned in consideration of the future project but operation in the initial stage will be by one circuit's stringing.

The outline of transmission lines to be provided in the 2nd stage is as follows:

i) 138 kV Transmission Line (New lines)

Line section:	Between Haina and the 138 kV SS in the city
Total length:	13 km
Voltage:	138 kV
Electric system:	3-phase, 3-wire system, 60 Hz
No. of circuits:	One circuit (supports designed for 2 circuits)
Conductor:	240 mm² ACSR

Insulator:	254 mm suspension insulator x (8 – 10)
Support:	Steel tower

ii) Transmission line between Timbeque and Arroyo Hondo (Replacement of conductors)

Line section:	Timbeque–LA 40–Arroyo Hondo SS Section
Total length:	8.1 km
Voltage:	69 kV
Conductor:	240 mm^2 ACSR

iii) 69 kV substation and distribution transformer

69 kV substations (new):	2 SS (28 MVA each)
Additional transformers (28 MVA):	5 banks for 4 substations 4 substations

Table 5–6 Outline of Substation Facility Works -- 2nd Stage
(Changes of Transformer Capacities)

Substation	MVA before work	MVA after work	Increase or decrease		Remarks
			Increase	Retired	
Los Prados	MVA 0	MVA 28.0	MVA x units 28 x 1	MVA x units –	Added
Ens Espaillat	0	28.0	28 x 1	–	Added
138 kV S/S	0	28.0	28 x 1	–	Added
Rojas	28.0	56.0	28 x 1	–	
Timbeque	93.4	121.4	28 x 1	–	
Herrera	51.375	84.0	28 x 2	9.375 x 1 14 x 1	
KM 10.5	35.5	56.0	28 x 1	7.5 x 1	
Matadero	22.4	36.4	14 x 1	–	Transformer ex Timbeque (Tap changed)
Los Mina	36.4	50.4	14 x 1	–	Transformer ex Herrera
LA 40	59.77	59.77	–	–	
Metropolitano	56.0	56.0	–	–	
Embajador	78.4	78.4	–	–	
Arroyo Hondo	28.0	28.0	–	–	
CN. Penson	56.0	56.0	–	–	
Villa Duarte	28.0	28.0	–	–	
Total	29 units 573.245	36 units 794.37	10 units 252.0	–3 units –30.875	

2) Distribution Line

For the 2nd stage, construction of distribution lines to be continued from the 1st stage and additional works for improvement of system reliability were considered.

a) Construction of high voltage distribution lines

New feeders to be provided in conjunction with the construction of additional substations are as follows:

- o No. of feeders: 24
- o Total length of new distribution lines: 65 km
- o Conductor: ACSR 4/0 or over

b) Size up of conductors and change to 3-phase

- o Total length of trunk lines to be replaced: 100 km
- o Total length of lines to be changed to 3-phase: 70 km
- o Conductor: ACSR 2/0 or over

(For branch lines to be changed to 3-phase, conductor size may be the same as that of phase conductor of existing single phase)

c) Improvement of distribution lines in slum area

The remaining half of the total work quantity described in the section for the 1st stage construction will be accomplished in this stage.

- o No. of poles to be provided: 2,300
- o Length of H.V. lines to be extended: 20 km
- o Length of L.V. lines to be extended: 115 km
- o No. of service wires: 25,000
- o No. of W.H. meters: 25,000

d) Improvement of low voltage distribution lines

- o Total length of L.V. lines: 100 km
- o Conductor: OW wire

e) D.M. system (Fault detecting relay system with time delay magnetic switch)

This system automatically detects and disconnects the fault section in case of a fault in the distribution system and enables early detection of a fault in the system. The system has a special feature that it is possible to know after which disconnecting switch the fault has occurred from the position of the pointer of indicator provided at the substation.

This system will be provided for all feeders including those planned for the 3rd stage construction.

- o Feeders: 124 feeders
- o Disconnecting switches: 620 units
- o Relay box: 620 each
- o Indicator: 124 each

f) Lightning arrester

All poles with transformers will be equipped with a lightning arrester. It is assumed, however, that approximately half of the existing poles with transformers have arrestors already installed. The remaining half of the poles, therefore, will be equipped with an arrester.

This work will be allocated to the 2nd and 3rd stage construction, with one half of the work to be accomplished in the 2nd stage as follows:

- o Arresters to be installed: 1,600 each

g) Insulated wire

The northern section of the Colonial district is a built-up area, where high voltage lines run so close to the dwellings that they can be easily reached from windows in some cases.

Due to the fact that streets are so narrow that relocation of distribution lines is almost impossible, part of the line in critical sections will be changed to insulated wires for safety of the public.

- Total length of lines to be replaced: 20 km
- Conductor to be used: Cross-linked polyethylene insulated wire (Conductor size will be increased by one grade).

5 - 5 3rd Stage Construction Plan

1) Transmission Line and Substation Facility

In the 3rd stage, one additional circuit of 138 kV transmission line and one additional bank of transformer will be provided at the 138 kV substation to be constructed in the 2nd stage. For existing substations, additional transformers will be installed.

The outline of transmission line and substation facility to be provided in the 3rd stage is as follows:

a) 138 kV transmission line (stringing of one additional circuit)
   - Line section: Between Haina PS and 138 kV as in the city
   - Total length: 13 km
   - Voltage: 138 kV
   - Conductor: 240 mm² ACSR

b) 69 kV distribution transformers for substations
   - Transformers to be added: 28 MVA 9 banks for 7 substations

Table 5–7 Outline of Substation Facility Works – 3rd Stage
(Changes of Transformer Capacities)

Substation	MVA before work	MVA after work	Increase or decrease		Remarks
			Increase	Retired	
Rojas	MVA 56.0	MVA 84.0	MVA x units 28 x 1	MVA x units –	
Metropolitano	56.0	70.0	28 x 1	14 x 1	
LA 40	59.77	78.4	28 x 1	9.37 x 1	
Villa Duarte	28.0	56.0	28 x 1	–	
Los Prados	28.0	84.0	28 x 2	–	
Ens Espaillant	28.0	56.0	28 x 1	–	
138 kV S/S	28.0	84.0	28 x 2	–	
Matadero	36.4	50.4	14 x 1	–	Transformer ex Metropolitano
Los Mina	50.4	50.4	–	–	
Timbeque	121.4	121.4	–	–	
CN. Penson	56.0	56.0	–	–	
Arroyo Hondo	28.0	28.0	–	–	
Embajador	78.4	78.4	–	–	
KM 10.5	56.0	56.0	–	–	
Herrera	84.0	84.0	–	–	
Total	36 units 794.37	44 units 1,037.0	10 units 266.7	–2 units –23.37	

2) Distribution Line

The work of the 3rd stage construction will be carried out in succession to the 2nd stage construction.

a) Construction of new high voltage distribution lines

Construction of new feeders in conjunction with the construction of additional substations and installation of additional transformers is as follows.

- Feeders to be provided: 27 feeders

- Total length of new distribution lines to be constructed:; 73 km;
- Conductor: ACSR 4/0 or ACSR 266 MCM

b) Improvement of low voltage distribution lines

- Total length of L.V.D. lines: 200 km
- Conductor: OW

c) Lightning arrester

- No. of arresters to be installed: 1,600 banks

d) Insulated wire

- Feeder to be insulated: Matadero SS No. 2 feeder
- Total length to be replaced: 20 km
- Conductor: Cross-linked polyethelene insulated wire

e) Tools and instruments

These are for replacement purpose and the quantity is the same as that for the 1st stage construction.

Chapter 6. Construction Cost

6 - 1 Total Construction Cost

For construction cost, the direct construction cost was first calculated for individual facilities such as transmission line, substation and distribution line and then contingencies and engineering fee were added to the total of direct construction cost.

A tabulation of construction costs is shown in Table 6 - 1 and the total construction cost by project stage is shown in Table 6 - 2.

Table 6 - 1 Total Construction Cost

Unit : 10^6 Yen

ITEM	1st. Stage Foreign Curren.	1st. Stage Local Curren.	1st. Stage Total	2nd. Stage Foreign Curren.	2nd. Stage Local Curren.	2nd. Stage Total	3rd. Stage Foreign Curren.	3rd. Stage Local Curren.	3rd. Stage Total	Total Foreign Curren.	Total Local Curren.	Total Total
(1) Transmission	(317)	(72)	(389)	(1870)	(777)	(2647)	(638)	(194)	(832)	(2825)	(1043)	(3868)
Facilities	79	18	97	468	194	662	160	48	208	707	260	967
(2) Substation	(4328)	(553)	(4881)	(6549)	(876)	(7425)	(8601)	(894)	(9495)	(19478)	(2323)	(21801)
Facilities	1082	138	1220	1637	219	1856	2150	224	2374	4869	581	5450
(3) Distribution	(10383)	(8612)	(18995)	(9859)	(2631)	(12490)	(6528)	(1428)	(7956)	(26770)	(12671)	(39441)
Facilities	2595	2155	4750	2466	659	3125	1633	358	1991	6694	3172	9866
A=(1)+(2)+(3)	(15028)	(9237)	(24265)	(18278)	(4284)	(22562)	(15767)	(2516)	(18283)	(49073)	(16037)	(65110)
Direct Const. Cost	3756	2311	6067	4571	1072	5643	3943	630	4573	12270	4013	16283
Contingency	(2254)	(1386)	(3640)	(2742)	(643)	(3385)	(2365)	(377)	(2742)	(7361)	(2406)	(9767)
B = 0.15 x A	563	347	910	686	146	832	591	95	686	1840	588	2428
Sub Total	(17282)	(10623)	(27905)	(21020)	(4927)	(25947)	(18132)	(2893)	(21025)	(56434)	(18443)	(74877)
C = A + B	4319	2658	6977	5257	1218	6475	4534	725	5259	14110	4601	18711
Engineering Fee	(1051)	(647)	(1698)	(1279)	(300)	(1579)	(1104)	(176)	(1280)	(3434)	(1123)	(4557)
D = 0.07 A	263	162	425	320	75	395	276	44	320	859	281	1140
Training Cost	(160)		(160)							(160)		(160)
E.	40		40							40		40
TOTAL Const. Cost	(18493)	(11270)	(29763)	(22299)	(5227)	(27526)	(19236)	(3069)	(22305)	(60028)	(19566)	(79594)
F = C + D + E	4622	2820	7442	5577	1293	6870	4810	769	5579	15009	4882	19891

Note: Exchange rate US$ 1 = ¥ 250 = RD$ 1
The figures in parentheses show the required amount of fund in 10^3 RD$

Table 6 - 2 Summary

Table 6 - 2 Summary

	Foreign Currency	Local Currency	Total Amount
1st Stage Works	(18,493) 4,622	(11,270) 2,820	(29,763) 7,442
2nd Stage Works	(22,299) 5,577	(5,227) 1,293	(27,526) 6,870
3rd Stage Works	(19,236) 4,810	(3,069) 769	(22,305) 5,579
TOTAL	(60,028) 15,009	(19,566) 4,882	(79,594) 19,891

Note : The figures in the parentheses show the required amount of fund in 10^3 Peso and those without the parentheses in 10^6 yen.

6 - 2 Basis for Computation of Construction Cost

1) Foreign Currency and Local Currency Portions

Allocation of procurement to foreign currency and local currency portions is as follows:

Item	Foreign Currency	Local Currency	Remarks
Equipment & materials	O	Miscellaneous materials available for procurement by local currency	
Construction Cost:			
Substation	O	Inland transportation	
Transmission Line	O	Civil work	
Distribution line (Overhead)	O	Labor cost and inland transportation	
Distribution line (Underground)	O	Inland transportation, civil work	

Note: Local labor force was considered for construction work of transmission lines and substations and labor cost was allocated to local currency.

2) Computation of Construction Cost

a) Direct Construction Cost

i) Cost of Equipment and Materials

Unit costs of equipment and materials were calculated by adding ocean freight, insurance premium and other necessary costs to the standard unit cost adopted by Japanese Electric Power Companies in 1979 and the unit cost applied to the recent purchases by CDE.

ii) Labor Cost

Labor cost was calculated by adding the cost of dispatching foreign engineers, cost of temporary facilities and miscellaneous expenses to the local unit labor cost.

iii) Cost Escalation

Cost escalation from 1979 to the center year of each construction stage was considered. An annual escalation rate of 5 % was considered for both material cost and labor cost.

b) Contingencies

Contingencies equivalent to 15 % of direct construction cost were considered.

c) Consultant fee

Consultant fee equivalent to 7 % (both in foreign and local currencies) of direct construction cost was considered.

d) Cost of Technical Training

Expenses for dispatching instructors were allocated to foreign currency and expenses related to trainees were allocated to local currency (For details of training program, refer to Chapter 7).

6 - 3 Loan Requirement by Fiscal Year

Loan demand by item for 1st, 2nd and 3rd stages is shown in Table 6 - 2 and loan demand by fiscal year for the 1st stage construction is shown in Table 6 - 3.

Table 6 - 3 Foreign Currency Required By Fisical Year (1st stage)

Unit : 10^6 Yen

Items	Total			1980			1981			1982		
	F C	L C	Total	F C	L C	Total	F C	L C	Total	F C	L C	Total
(1) Transmission Facilities	(317) 79	(72) 18	(389) 97	-	-	-	(95) 24	-	(95) 24	(222) 55	(72) 18	(294) 73
(2) Substation Facilities	(4328) 1082	(553) 138	(4881) 1220	-	-	-	(864) 216	-	(864) 216	(3464) 866	(553) 138	(4017) 1004
(3) Distribution Facilities	(10383) 2595	(8612) 2155	(18995) 4750	-	-	-	(2080) 520	(800) 200	(2880) 720	(8303) 2075	(7812) 1955	(16115) 4030
A. Direct Construction Cost	(15028) 3756	(9237) 2311	(24265) 6067	-	-	-	(3039) 760	(800) 200	(3839) 960	(11989) 2996	(8437) 2111	(20426) 5107
B. Contingencies(A x 0.15)	(2254) 563	(1386) 347	(3640) 910	-	-	-	-	-	-	(2254) 563	(1386) 347	(3640) 910
C. Engineering Fee	(1051) 263	(647) 162	(1698) 425	-	-	-	(640) 160	(400) 100	(1040) 260	(411) 103	(247) 62	(658) 165
D. Training Cost	(160) 40	-	(160) 40	-	-	-	(160) 40	-	(160) 40	-	-	-
E. (A+B+C+D) Total Construction Cost	(18493) 4622	(11270) 2820	(29763) 7442	-	-	-	(3839) 960	(1200) 300	(5039) 1260	(14654) 3662	(10070) 2520	(24724) 6182

The figures in paranthesos show the required amount of fund in 10^3 peso.

Note: F.C. ... Foreign currency; L.C. ... Local currency;

Chapter 7. Implementation of the Project

7-1 Set-up for Implementation of Project

1) Contract Methods for Material Procurement and Execution of Construction Work

For the procurement of materials and execution of construction work under the project, adoption of dual contract methods, the turn-key base contract and the supply base contract, according to the type of service was considered with reference to the contract method adopted by CDE in the past.

a) Works to be provided under turn-key base contract

- o Transmission lines
- o Substations
- o Underground cables of distribution system

Since these works require a relatively high level of technology and should be guaranteed for material, the so-called turn-key base contract, under which the same contractor supplies materials and executes construction work, was considered.

This is a system in which contractor or contractors, after making tenders for specifications prepared by a consultant and after being awarded a contract, execute the contract work consistently from manufacturing, transportation to erection at the construction site.

For civil work portions of the construction work, however, local contractors may be selected in the form of sub-contract or under separate contract.

For supply of wood poles among materials, a separate contract may be considered for procurement together with procurement of wood poles for overhead distribution lines mentioned in the next section.

b) Work to be provided under supply base contract

- Overhead distribution lines

Construction of overhead distribution lines has been carried out directly by CDE to the date. Since the expansion of the distribution system under the project involves construction of new lines or alteration of existing lines within the area served by the existing distribution system, execution of work is a little complicated with the requirement for stopping power supply to the section involved. For this reason, the supply base contract method is desirable for this portion of work. In this method, a contractor is responsible for manufacturing and transportation of equipment and materials and CDE takes charge of construction work as its direct undertaking.

For supply of wood poles, however, a separate contract may be concluded as mentioned previously.

2) Training of CDE Technicians

It is the desire of CDE to provide training courses for its technicians to ensure smooth progress of the project and to develop capable technicians. The following group training courses will be provided for CDE technicians.

a) Training Subjects

- Techniques of handling aluminium conductors (stringing and connection techniques)
- Techniques of pole erection
- Use of new equipment and tools
- Improved method of attaching accessories to poles
- Work safety
- Techniques of measurement and report system

b) Applicable Personnel and Training Period

Approximately 80 distribution technicians and foremen will be divided into groups of 15 to 20 persons and will be trained for about two months.

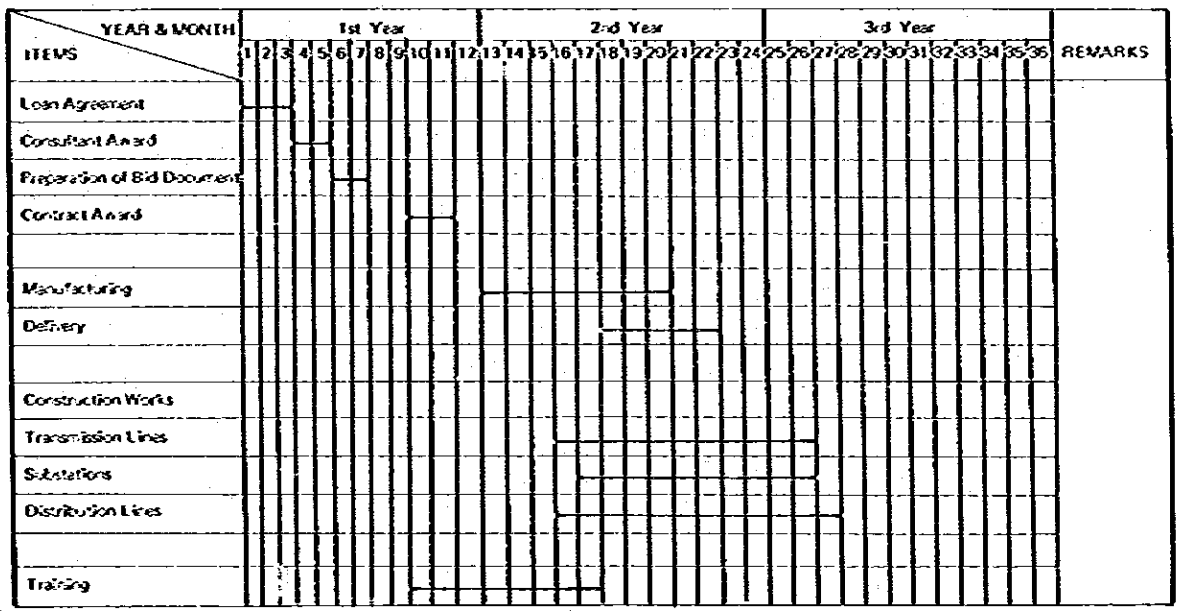
c) Training Method

After group training with instruction manuals for about two weeks, trainees will be given on-the job training for the remaining period.

Note: In addition, training of CDE engineers on engineering, construction supervision and system management will be required.

It may be appropriate to request the consultant to provide such training.

Table 7 - 1 Tentative Overall Construction Schedule



7 - 2 Construction Schedule

A tentative construction schedule for the project is shown in Table 7 - 1.

Chapter 8. Economic Assessment of the Project

8 - 1 Benefits of Distribution System Modernization Project

For the implementation of this Distribution System Modernization project, a total of 19.9 billion yen will be invested during a period of 10 years, with allocation of 7.4 billion yen to the 1st stage, 6.9 billion yen to the 2nd stage and 5.6 billion yen to the 3rd stage. The total amount may be broken down to 15.0 billion yen (75.4 %) of foreign currency and 4.9 billion yen (24.6 %) of local currency.

This project is expected to bring about the following benefits.

i) Reduction of transmission and distribution losses.

ii) Establishment of a reliable distribution system capable of meeting the increase of demand.

iii) Conversion of sections of high voltage distribution lines to underground cables.

iv) Improvement of pole assembling and line route of low voltage distribution lines.

8 - 2 Improvement of System Reliability

1) Transmission Lines

A transmission lines directly interconnecting the Haina PS, a major power source in the west, and Timbeque, a main load section in the east, within the city will be provided in the 1st stage of the project. In the 2nd stage, the 138 kV transmission line will be extended to the center of the city to augment the existing transmission system.

2) Distribution substations

The target utilization factor of 70 % will be attained for distribution transformers to adequately meet the increase of demand as show in Fig 8–1.

3) High and Low Voltage Distribution Lines

For the expansion of the high voltage distribution lines, all of the 8 feeders of 4.16 kV lines will be uprated to 12.5 kV. At the same time, the number of feeders of trunk distribution lines, which is 48 as of March 1980, will be increased by 78, with 27 feeders to be provided in the 1st stage, 24 feeders in the 2nd stage and 27 feeders in the 3rd stage, to meet demand increase in the future.

A underground cable system will be completed in Colonial district.

For modernization of low voltage distribution lines, a separate purchase contract will be made for a total of 17,100 wood poles, which are broken down into 6,200 poles in the 1st stage, 6,600 poles in the 2nd stage and 4,300 poles in the 3rd stage, 136,000 units of kWh meter, pole mounted transformers and necessary conductors.

8 - 3 Reduction of Transmission and Distribution Loss

1) Changes in Transmission Line and Substation Loss Rate

Changes in transmission line and substation loss rate (annual) for representative years are shown in Table 8-1. It is known from the table that the loss rate can be held down against the increase of demand.

Table 8 - 1 Changes in Loss Rate

		1979	1980	1982	1985	1990
T/L & SS	%	2.4	2.5	2.1	2.7	
D/L	%	21.8	23.4	20.0	17.3	16.3
Total	%	24.2	25.9	22.1	20.0	–

2) Changes in Distribution Line Loss Rate

The energy loss in various parts of distribution lines against the sale of 938,000 MWh of electricity in 1979 is shown in Table 8 - 2.

Fig 8 - 1 Estimated Peak Demand and Substation Transformer Capacity

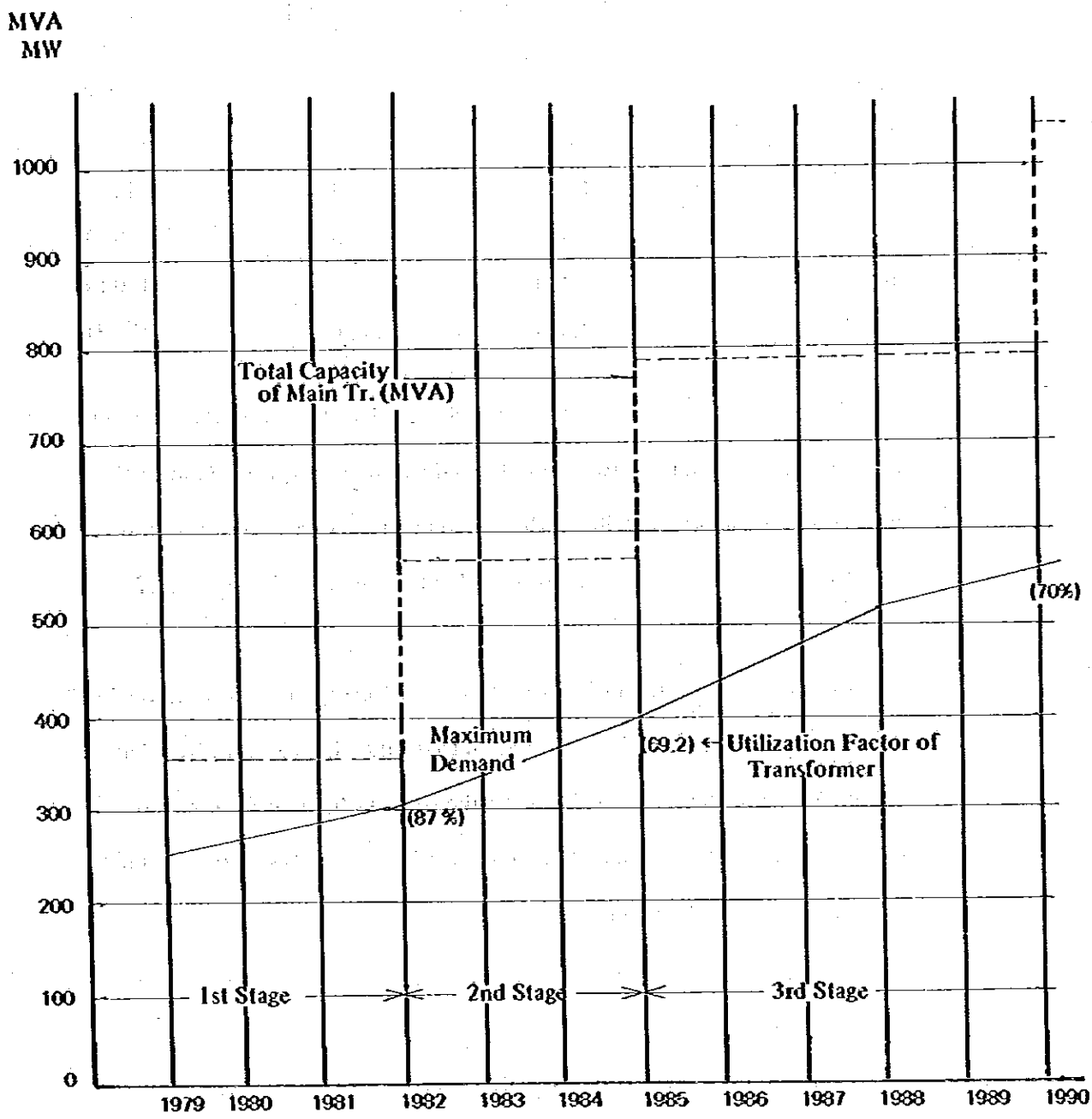


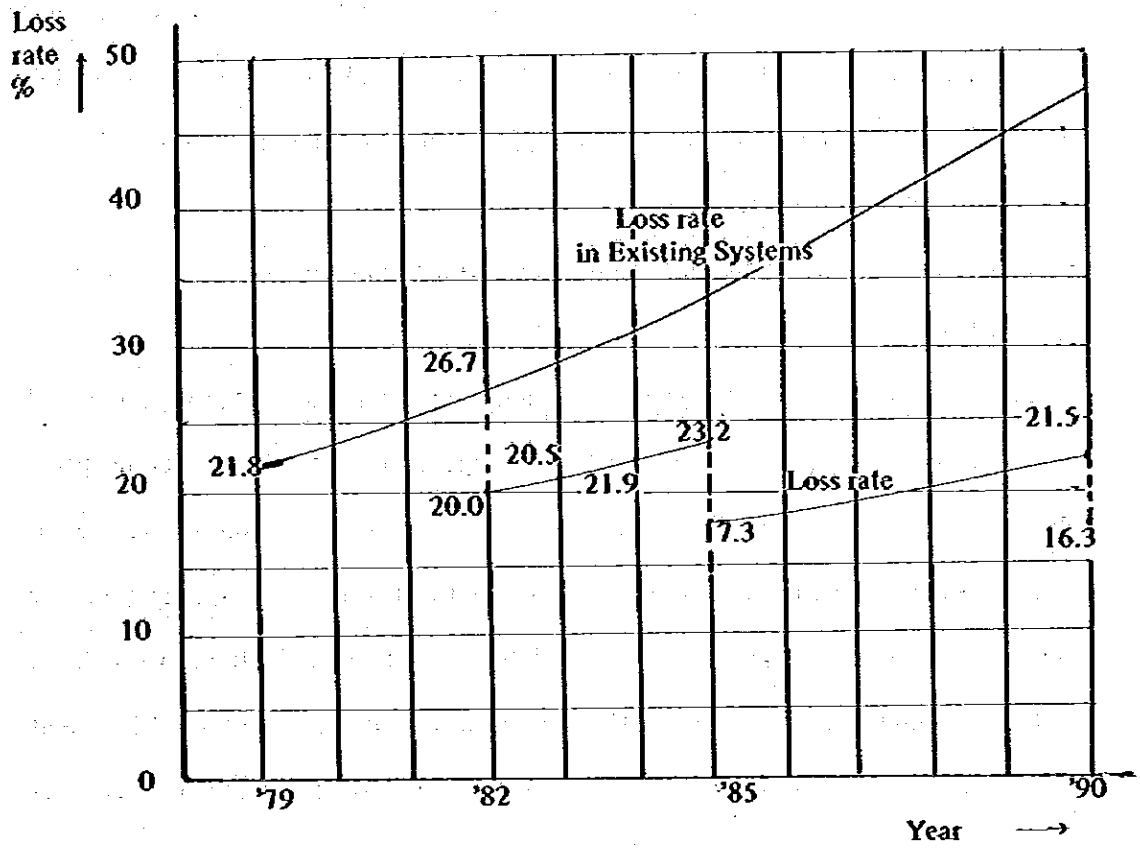
Table 8 - 2 Breakdown of Distribution Line Loss (In 1979)

	Amount of loss	Loss rate	Loss rate in 1990
	10^6 kWh	%	
H. V Feeder	48.7	3.9	(2.0)
Dist. & Trans. lines	17.3	1.4	(1.4)
L.V. Bus	166.9	13.5	(12.0)
Service wire	6.7	0.5	(0.4)
Rob	30.0	2.4	(0.5)
Total	269.6	21.8	(16.3)

The completion of the Distribution System Modernization Project (under planning) is expected to contribute to the reduction of energy loss in low voltage lines and high voltage trunk lines, which accounts for a greater portion of loss rate in distribution lines, and to the considerable reduction of the number of illicit consumers.

Changes in loss rate of distribution lines, with comparison between the loss rate for nonimproved distribution lines and that for each stage of the Distribution System Modernization Project, based on the demand forecast for each year, are shown in Fig. 8 - 2. The loss rate, which was 21.8 % in 1979, is expected to be reduced by 5.8 % to 16.3 % in 1990.

Fig. 8 - 2 Changes in loss rate of distribution line (1979 – 1990)



8 - 4 Internal Rate of Return (IRR)

A disbursement plan of Project Funds by year is shown in the preceding Table 6 - 3 According to the table, outlays of 1.3 billion yen (US$, 5 million) and 6.2 billion yen (US$, 24.7 million) in bothe foreign and local currencies are scheduled for 1981 and 1982, respectively.

The calculation of IRR for the 1st stage of construction is based on this disbursement plan.

In general, the amount of capital spending for transmission lines, substations and distribution lines varies with power companies depending on the size of their facilities. When the capacity of a power system is small and the 200 kV transmission system is introduced for the first time, the construction cost of distribution system generally accounts for 60 to 70 per cent of the total capital investment for transmission lines, substations and distribution lines. This rate, however, decreases to 50 to 55 percent when the 200 kV transmission system is used as the main system and further decreases to 35 to 45 percent when the 500 kV transmission system is introduced.

In the existing power system of Repulica Dominicana, the rate of capital investment for distribution system is also high. However, in this stage when the construction of new 138 kV transmission lines is in progress, the share of distribution system in total capital investment may be considered to be 50 percent.

Because the cost of distribution facilities for new consumers are not included in this project, 32 percent of the total of actual increase of revenue (sales of electricity minus power generation cost) due to demand increase for each year and the saving in generation cost due to the reduction of transmission and distribution loss rate can be considered as a gain from the project.

Calculation of IRR based on this gain is shown in Table 8 - 3. Calculation of merit at an interest rate of 10 % is shown in Tables 8 - 4 and 8 - 5. As a result of this computation, IRR was determined to be 20.05%, which justifies the feasibility of this project.

Table 8 - 3 Calculation of IRR (1st Stage)

Interest Rate		10 %	20 %	25 %
Total cost (Present Value)	10^6 RD$	24.95	21.31	19.81
Estimated Revenue (Present Value)	10^6 RD$	44.00	21.25	16.10

IRR..... 20.05%

Table 8 - 4 Merit Calculation (1st stage)

Demand Categories	Unit price	Unit	1979	1980	1981	1982	1983	1984	1985
Residential	¢ 5.05	10^6 kWh	303.3	338.1	372.9	407.8	464.5	521.2	578.1
		10^6 RD$	15.3	17.1	18.8	20.6	23.4	26.3	29.2
Commercial	¢ 6.81	10^6 kWh	131.3	148.9	166.5	184.1	211.4	238.7	266.0
		10^6 RD$	8.9	10.1	11.3	12.5	14.4	16.2	18.1
Industry	¢ 5.55	10^6 kWh	438.8	483.5	518.2	573	658	743	828.2
		10^6 RD$	24.3	26.8	28.8	31.8	36.5	41.2	46.0
Government	¢ 5.05	10^6 kWh	64.7	66.7	68.7	70.7	73.5	76.3	79.1
		10^6 RD$	3.3	3.4	3.5	3.6	3.7	3.8	4.0
Total		10^6 kWh	938	1037	1126.3	1235.7	1407.1	1578.5	1751.4
		10^6 RD$	51.8	57.4	62.4	68.5	78.0	87.5	97.3
	Incremental revenue		–	5.6	5.0	6.1	9.5	9.5	9.8
	Ratio of loss		24.2	25.9	27.3	22.1	22.7	24.2	20.0
		10^6 kWh	1237.5	1399.4	1549.2	1586.3	1820.3	2087.4	2189.2
	¢ 3.40	10^6 RD$	42.1	47.6	52.6	53.9	61.9	70.8	74.4
	Incremental generation cost		–	5.5	5.0	1.3	8.0	11.1	3.6
Balance				0.1	0	4.8	1.5	– 1.6	6.2
Accumulation (A)					–	4.8	6.3	4.7	–
Loss, in Existing Facility		10^6 kWh				488.9	633	862.1	
Loss, improved		10^6 kWh				337.1	395	478	
Decrease of loss		10^6 kWh				151.8	238	384.1	
Amount (B)	¢ 3.40	10^6RD$				5.2	8.1	13.0	
Total Gain		10^6 RD$				10.0	14.4	17.7	

Table 8 - 5 Calculation of IRR: Interest rate 10 %

No.	Year	Construction Cost 10^6 RD$	Sold power 10^6 kWh	Incremental Value: Revenue RD$0.055 per kWh	Incremental Value: Power Cost RD$0.034 per kWh	Incremental Value: Net Income 10^6 RD$	Incremental Value: Loss to be Decreased 10^6 RD$	Revenue 10^6 RD$	Present Value Factor	Present Value 10^6 RD$: Construction Cost	Present Value 10^6 RD$: CDE's Revenue 10^6 RD$
1	1981	5.0	1126.3	62.4	52.6	–	–	–	0.9091	4.54	–
2	1982	24.7	1235.7	68.5	53.9	4.8	5.2	10.0	0.8264	20.41	8.26
3	1983	–	1407.1	78.0	61.9	6.3	8.1	14.4	0.7513	–	10.82
4	1984	–	1578.5	87.5	70.8	4.7	13.0	17.7	0.6830	–	12.09
5	1985	–	1751.4	97.3	74.4	–	–	17.7	0.6209	–	10.99
:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:
24	2004							17.7	0.1015	–	1.80
25	2005							17.7	0.0923	–	1.63
TOTAL										24.95	135.79

APPENDIX 1 A STUDY OF UNIT CAPACITY OF SUBSTATION TRANSFORMERS

1. Size of Distribution Substation

a) Proper Capacity of Distribution Substations

The result of a study on this subject made by Mr. Tsuru of Kyushu Electric Power Company, Japan, may be summarized as follows:

(Case: Distribution voltage of 6.9 kV and transmission voltage of 66 kV)

The relation between the service area of a substation and the load density is as shown in Fig. 1. In the figure, the service area is 2.8 km^2 ~ 0.7 km at a load density of 10 MV/km^2 and 4.5 km^2 ~ 2.8 km^2 at a load density of 5 MW/km^2. In such small areas, however, the operation of distribution lines is restricted by the carrying capacity of conductor. From this, the service area approximately twice as large as the aforementioned is considered to be the appropriate size when the distribution voltage is doubled to 13.5 kV. That is, the appropriate service area is 5.5 km^2 ~ 1.4 km^2 at a load density of 10 mw/km^2 and 9 km^2 ~ 5.6 km^2 at a load density of 5 MW/km^2. From the standpoint of maximum service area, the maximum load served by a substation may be determined to be 55 MW at a load density of 10 MW/km^2 and 45 MW at a load density of 5 MW/km^2.

b) Relationship between Utilization Factors of Facilities and the Capacity of Distribution Substations

Appropriate substation capacities with variable substation utilization factor (α_S), transformer utilization factor (α_T) and distribution line utilization factor (α_D) are shown in Fig. 2 (a), (b) and (c). When the substation utilization factor is 0.8, the appropriate capacity per a substation is 18 MW at a load density of 3 MW/km^2 and 28 MW at a load density of 7 MW/km^2. At a load density of 10 MW/km^2, the appropriate capacity per a substation is considered to be 35 MW.

Since the above value is for the distribution voltage of 6.9 kV, the value approximately twice this value must be considered for the distribution voltage of 13.5 kV. In such a case, the appropriate capacity per a substation is considered to be 70 MW at a load density of 10 MW/km^2.

c) Statistics of Distribution System in Major Cities, Kyushu, Japan

Statistics of distribution substations in major cities served by Kyushu Electric Power Company for 1975 in comparison with the study made by Mr. Tsuru are shown in Table 1. According to the Table, a city with a service area of about 140 km^2 is provided with 10 to 23 substations.

Table 1. A comparison between actual Power Co.'s Plan and Mr. Tsuru's study

As of 1975. In Kyushu.

	Load (MW)	Area (km^2)	Mr. Tsuru's study		Kyushu Power Co.'s plan. No. of ss.
			No. of ss.	ss. capacity (MVA)	
Fukuoka city	477	147	23 ~ 42	14 ~ 26	23 + s
Kokura Dis. Kitakyushu city	153	72.9	9 ~ 15	13 ~ 21	6 + s
Kumamoto city	231	168.9	16 ~ 26	17 ~ 30	10 + s

Note: s ... No. of ss. not determined in 1972.

d) A Study of Appropriateness of Providing a New Substation for Reduction of High Voltage Line Loss

Annual energy losses of high voltage distribution lines of related substations calculated at the 1980 load for the case in which a new substation is provided between Herrera SS and KM 10.5 SS in Santo Domingo City and for the case in which the distribution lines of Herrera SS are reinforced are shown in Table 2.

Table 2 A Comparison of Measures for Reduction of Energy Loss of High Voltage Distribution Lines

	Loss at present	Loss after measures are taken	Amount of reduction	Rate of reduction
Construction of a substation	4,847 MWh	3,806 MWh	Δ1,041 MWh	21 %
Reinforcement of existing high voltage distribution lines	7,234 MWh	5,906 MWh	Δ1,328 MWh	20 %

There is no substantial difference in the reduction of energy loss between the two measures. It may be appropriate, therefore, to reinforce the existing high voltage distribution lines and continue to use them until the planned facilities of Herrera SS (28 MVA x 3) attain a utilization factor of about 0.7 in the supply of load.

2. Conclusion

From these study results, it may be concluded that in Santo Domingo City the load of one substation in urban area is approximately 60 MW and the load of one substation in the residential district in the suburbs is about 40 MW.

At a substation utilization factor of 0.7, the standard capacity of a substation may be about 90 MVA in the urban area and approximately 60 MVA in the suburbs.

As the standard number of transformer banks in one substation is considered to be 3, the transformer capacity per bank may be around 30 MVA in the urban area and around 20 MVA in the suburbs.

For this reason, the bank capacities of 28 MVA and 22 MVA considered by CDE as standard capacities will be adopted.

Appendix 1

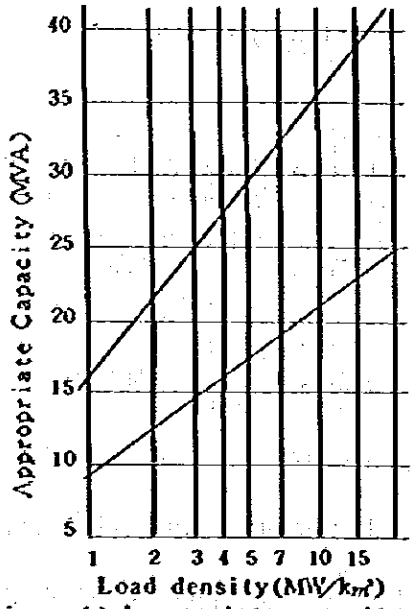


Fig. 1 (a) Appropriate capacity of substation

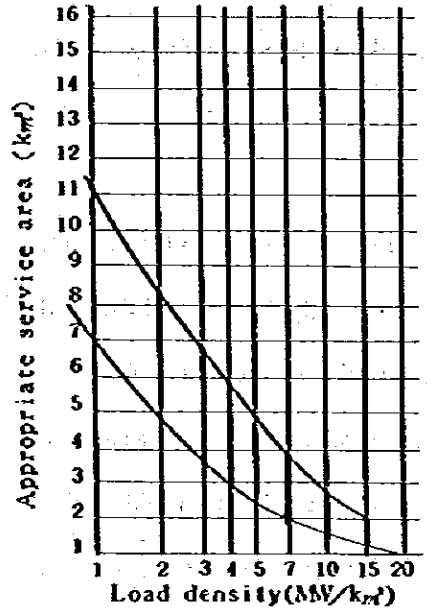


Fig. 1 (b) Appropiate service area of substation

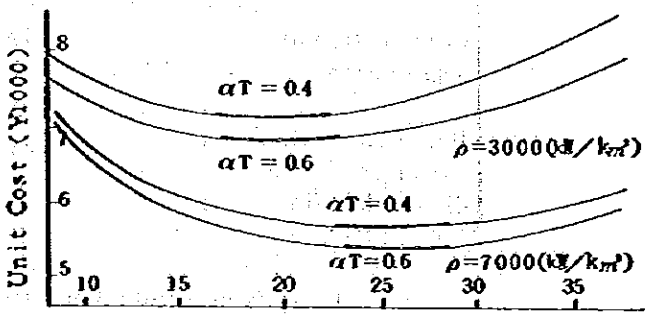


Fig 2 (a) Case (a) $\alpha s=0.8$, $\alpha D=0.4$

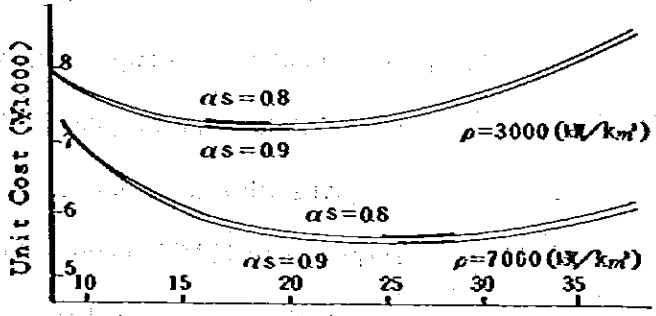


Fig. 2 (b) Case (b) $\alpha T=0.4$, $\alpha D=0.4$

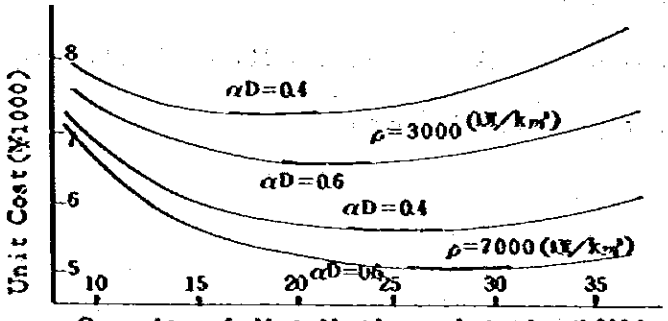


Fig 2 (c) Case (c) $\alpha T=0.4$ $\alpha s=0.8$

Appendix 2 Distribution Line Voltage Drop Calculation Sheet (Data)

Summary of High Voltage Distribution Lines Losses and Voltage Drops

Sub – station	Feeder	Supply voltage (kV)	Current (A) I_1	I_2	I_3	Trunk line Route length (km)	Line voltage drop (V)	Line losses (MWh/Year)	Total capacities of Pole Tr. (kVA)
Los Mina	No. 1	12.5	370	200	280	4.2	(3.7%) 269	(1.0%) 348	5,000
	No. 2	"	310	340	370	2.3	(2.1%) 154	(1.1%) 481	4,513
	No. 3	"	380	370	420	3.1	(5.1%) 369	(3.3%)1,653	5,911
	Exclusivo	"	60	60	60	0.3	(0.2%) 16	(0.2%) 12	975
Tinbeque	Industrial Plant	4.16	364	456	396	2.5	(9.2%) 221	(6.9%)1,169	4,177.5
	Mercedes	4.16	460	600	530	2.0	(11.6%) 280	(4.4%)2,180	4,181.5
	Padre Billini	4.16	850	1,080	710	3.1	(14.6%) 351	(8.7%)3,257	9,718
	Inde Penden cia	4.16	400	400	370	3.2	(9.6%) 232	(5.5%) 913	4,662.5
	Villa francisca	4.16	270	260	280	2.3	(8.8%) 211	(4.2%) 481	2,515
	Capotillo	4.16	175	315	180	1.7	(11.8%) 283	(3.3%)1,034	2,630
	Trinitarios	12.5	40	40	40	10.7	(4.0%) 291	(3.3%) 169	850
	Calle 8	"	285	295	265	3.2	(2.5%) 178	(1.4%) 513	8,128
	Villa Duarte	"	280	275	275	9.1	(5.9%) 431	(0.8%) 282	5,942.5
	Max. Gomez	"	85	145	175	2.3	(1.3%) 90	(0.9%) 149	3,037.5
	Maria Aux.	"	170	175	220	5.2	(2.9%) 206	(1.9%) 457	5,318.5
	Feb. De. Cemento	"	360	380	330	4.1	(6.6%) 474	(3.8%)1,694	5,850
	Luperon	"	310	310	240	4.9	(4.3%) 313	(3.4%)1,218	12,000
	Tiradentes	"	480	440	450	6.1	(11.6%) 841	(9.2%)5,333	16,487
C.N. Person	A – 1	"	160	190	200	3.0	(3.5%) 249	(1.7%) 394	11,452
	A – 2	"	350	360	370	1.5	(0.7%) 52	(0.3%) 133	14,002
	B – 1	"	43	30	14	0.7	(0.1%) 4	(0.1%) 4	2,827.5
	B – 2	"	390	360	360	1.0	(1.4%) 102	(1.0%) 467	3,690
La 40	Industrial	"	320	330	370	4.4	(3.4%) 243	(1.7%) 715	9,975
	La Fe	"	240	200	280	2.1	(2.0%) 146	(1.3%) 398	4,255
	Luperon	"	490	520	520	29.8	(21.5%)1,546	(5.1%)3,267	13,105
	Exclusivo 40	"	300	310	300	2.0	(2.1%) 153	(1.9%) 724	14,308

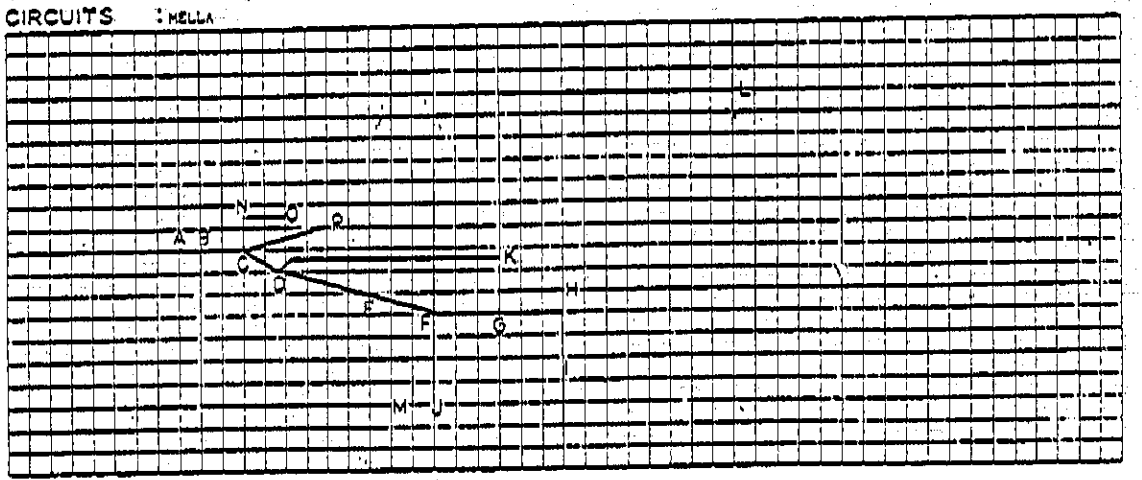
Note: Figure in ( ) represent voltage drop and conductor loss in percentage, respectively

Summary of High Voltage Distribution Lines Losses and Voltage Drops

Sub – station	Feeder	Supply voltage (kV)	Current			Trunk line Route length (km)	Line Voltage drop (V)	Line losses (MWh/Year)	Total capacities of Pole Tr. (kVA)
			I_1	I_2	I_3				
Metropolitano	A – 1	12.5	320	330	410	3.3	(4.0%) 286	(3.0%)1,354	6,906.5
	A – 2	"	500	530	520	2.1	(1.8%) 129	(1.1%) 693	18,745
	B – 1	"	475	400	400	2.9	(2.9%) 211	(1.8%) 965	14,093.5
	B – 2	"	17	29	18	1.1	(–) 2	(–) –	2,000
Embajador	Mella	"	400	460	580	7.6	(6.0%) 433	(3.0%)1,800	10,530
	Anacaona	"	420	480	600	6.0	(4.0%) 291	(1.9%)1,175	13,976.5
	Sauches	"	320	380	500	2.5	(5.5%) 393	(3.7%)1,872	6,811
	Duarte	"	340	300	300	5.5	(5.7%) 408	(6.0%)1,789	17,232
Matadero	No. 1	"	330	280	300	14.3	(11.6%) 838	(6.2%)2,395	16,893.5
	No. 2	"	300	300	290	3.4	(1.6%) 113	(0.8%) 309	13,375
La Feria	No. 1	4.16	528	486	498	0.9	(3.7%) 88	(2.2%) 469	6,870.5
	No. 5	4.16	700	840	744	5.7	(24.8%) 597	(12.0%)3,877	9,224.5
Arroyo Hondo	No. 1	12.5	390	280	310	3.5	(3.7%) 266	(2.4%)1,002	10,095
	No. 2	"	210	140	200	4.5	(3.9%) 282	(2.3%) 533	8,845
KM 10 1/2	No. 1	"	390	280	310	5.4	(2.5%) 181	(1.2%) 479	6,732
	No. 2	"	200	185	175	11.3	(4.5%) 322	(1.3%) 313	8,435
	No. 3	"	130	130	200	5.6	(1.5%) 105	(2.0%) 391	8,812
Herrera	No. 1	"	400	400	400	4.4	(4.1%) 298	(2.0%)1,036	22,404
	No. 2	"	240	175	200	1.7	(2.1%) 151	(1.1%) 284	9,743
	No. 3	"	340	120	200	2.7	(2.2%) 159	(2.0%) 544	9,003
Total 11ss	4 6					$\frac{209.2}{46\ cct} = 4.5\ \frac{km}{cct}$	(4.5%)	(3.02%) 48,725	334,437.5 kVA

DISTRIBUTION SYSTEM DESIGN

SUBSTATION : AMBAJADON
CIRCUITS : MELLA



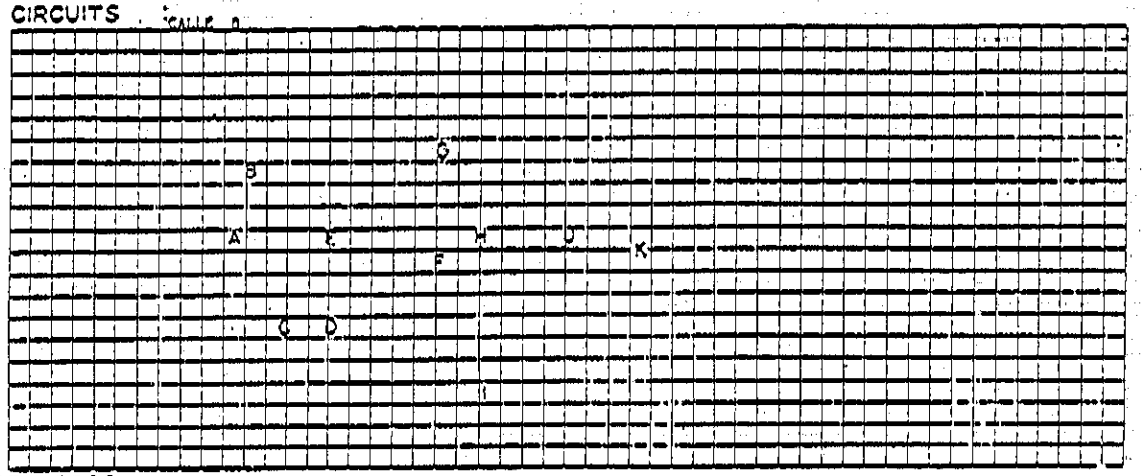
VOLTAGE DROP

SECTION	PHASE	CONDUCTOR SIZE (mm²)	VOLTAGE DROP FACTOR (V.F.)	LENGTH of SECTION (km)	V.F. x km (V/kw)	LOAD (KW) SECTION BRANCH	LOAD (KW) TOTAL (Sum of Above)	VOLTAGE DROP SECTION	VOLTAGE DROP TOTAL	r (Ω ohm/km)	LOSS KWH			
35 - A	3Ø4W	Cu4/0	0.263	0.31			580		48	0.172	53.8	Line length	7.6	Km
A - B	"	"	"	0.1			540		14	"	15.0	Voltage drop	532	V
B - C	"	Al4/0	0.375	0.41			485		75	0.276	49.8	% Voltage drop	6	0.7
C - D	"	"	"	0.30			275		42	"	21.8	Line loss	1800	MWH/Y
D - E	"	"	"	0.19			271		21	"	10.7	Sending power	60760	MWH
E - F	"	Cu2/0	0.37	1.51			191		107	0.273	45.1	Loss ratio	3	0.%
F - G	"	"	"	0.35			68		9	"	1.2			
G - H	"	"	"	1.10			20		8	"	0.4			
G - I	1Ø2W	Cu1/0	0.434	0.62			24		6	0.345	0.2			
F - J	3Ø4W	"	"	0.78			40		14	"	1.2	Actual current	Jan. 1980	
D - K	3Ø4W	Al4/0	0.375	1.87			202		130	0.276	61.9	I_{max} 400 a		
K - L	"	"	"	4.54			56		95	"	11.8			
D - M	"	Cu2/0	0.370	3.5			34		44	0.273	3.3	I_{pk} 460 a		
C - N	"	Al4/0	0.375	0.2			44		3	0.276	0.3			
N - O	1Ø2W	Cu1/0	0.868	0.4			20		0	0.345	0.1	I_{min} 500 a		
C - P	1Ø2W	Cu1/0	"	0.07			21		25	"	0.6			
Total											277.0			

DISTRIBUTION SYSTEM DESIGN

SUBSTATION : TIMBEQUE

CIRCUITS : CALLE 8



VOLTAGE DROP

SECTION	PHASE	CONDUCTOR SIZE (mm²)	VOLTAGE DROP FACTOR (D.F.)	LENGTH of SECTION (km)	D.F. x km (V/kw)	LOAD (KW) SECTION / BRANCH	LOAD (KW) TOTAL (Sum of Sect.)	VOLTAGE DROP SECTION	VOLTAGE DROP TOTAL	R ohm/km	Loss KWH	
SS - A	3ø4W	Al4/0	0.375	0.775			276		80	0.276	48.9	
A - E	"	Cu2/0	0.370	0.355			148		29	0.273	6.4	
E - F	"	"	0.370	0.71			125		33	"	9.1	
F - H	"	"	"	0.37			242		25	"	13.0	
H - J	"	Cu1/0	0.434	0.61			27		8	0.345	0.5	
J - K	"	"	"	0.44			13		3	"	0.1	
A - B	"	Cu1/0	"	0.445			24		5	"	0.3	
A - C	"	"	"	0.44			30		6	"	0.4	
C - D	1ø2W	Cu#6	2.84	0.29			4		4	1.355	-	
F - G	3ø4W	Cu2/0	0.370	0.615			18		5	0.273	0.2	
H - I	1ø2W	Cu#6	2.04	0.695			0		16	1.355	0.1	
...	...	...	...	...								
Total											79.0	

Line length 3.2 KM

Voltage drop 170 V

% Voltage drop 2 %

Line loss 513 KWH/Y

Section power 35701 KWH

Loss ratio 1.4%

Actual current Jan. 1980

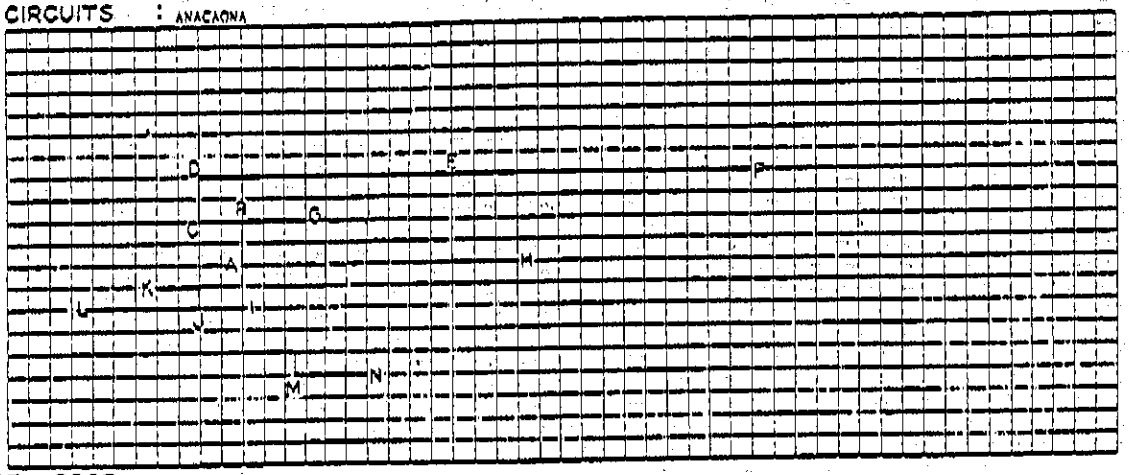
I_a ... 205 A

I_b ... 295 A

I_c ... 265 A

DISTRIBUTION SYSTEM DESIGN

SUBSTATION : EMBAJADOR
CIRCUITS : ANACAONA



VOLTAGE DROP

SECTION	PHASE	CONDUCTOR SIZE (mm²)	VOLTAGE DROP FACTOR (D.F.)	LENGTH of SECTION (km)	D.F. x km (V/kw)	LOAD (KW) SECTION ·BRANCH	LOAD (KW) TOTAL (Base of Cost.)	VOLTAGE DROP SECTION	VOLTAGE DROP TOTAL		R ohm/km	Loss KWH	
F - A	3Ø4W	Cu2/0	0.37	0.1			4000		23		0.273	39.5	
A - B	"	"	"	0.22			229		19		"	9.4	
B - C	"	"	"	0.32			190		19		"	8.0	
C - D	"	"	"	0.39			178		26		"	10.1	
D - E	"	"	"	2.02			142		109		"	34.0	
E - P	"	"	"	3.0			66		96		"	18.2	
B - G	"	"	"	0.92			10		5		"	0.2	
E - H	1Ø2W	Cu1/0	0.660	1.10			26		25		0.345	0.5	
A - I	3Ø4W	Cu2/0	0.37	0.16			321		19		0.273	13.5	
I - J	"	"	"	0.34			266		34		"	19.7	
J - K	1Ø2W	"	0.74	0.14			9		-		"	-	
J - L	"	"	"	1.12			242		202		"	36.1	
I - M	3Ø4W	"	0.37	0.73			62		14		"	1.6	
M - N	1Ø2W	"	0.74	0.54			11		4		"	-	
Total												180.8	

Line length ... Km
Voltage drop ... %
Power/amp. drop ... KVA-%
Loss/year ... MWH
Sending P. ... 300 MWH
Load ratio ... %
Actual load Jan. 1980
I_a ... 420 a
I_b ... 400 a
I_c ... 600 a

Appendix 3. Detailed Construction Cost, Unit Price Lists

Appendix 3 - 1 Construction cost of Substation and Transmission Line

A) Substation Facilities

Name of S.S.	Content	Construction Cost F.C.	Construction Cost L.C.	Total Cost
Rojas	28MVA 1 unit New construction	144,600	27,700	172,300
C.N. Penson	28MVA 1 unit Transformer increase	116,300	12,600	128,900
Metropolitano	– ditto –	116,300 – ditto –	12,600 – ditto –	128,900 – ditto –
LA 40	– ditto –	116,300 – ditto –	12,600 – ditto –	128,900 – ditto –
Embajador	28MVA 2 unit Transformer increase	232,600	25,200	257,800
Herrera	28MVA 1 unit Transformer increase	116,300	12,600	128,900
Timbeque	– ditto –	116,300 – ditto –	12,600 –ditto –	128,900 – ditto –
Arroyo Hondo	14MVA 1 unit Transformer increase	43,300	7,900	51,200
KM 10.5	– ditto –	43,300 – ditto –	7,900 –ditto –	51,200 – ditto –
Timbeque & C.N. Penson	69 kV T/L drawing out facilities	36,600	6,600	43,200
Total		1,081,900	138,300	1,220,200

B) Transmission Line Facilities

69 kV T/L	(Feria . . . Timbeque) New construction	70,000	15,900	85,900
69 kV T/L	(Matadro . . . Feria) Conductor size up	9,300	2,100	11,400
Total		79,300	18,000	97,300

Note: F.C. ... Foreign currency
L.C. ... Local currency

Appendix 3 - 2 Details of Construction Cost of Substations

(Case: New construction 28 MVA 1 unit S.S.)

Unit : 10^6 ¥

Item	Unit	F.C. Portion Unit	F.C. Q'ty	F.C. Cost	L.C. Portion Unit	L.C. Q'ty	L.C. Cost	Total Cost
Transformer 28 MVA 69/12.5 kV	Unit	67.9	1	67.9	6.0	1	6.0	73.9
OCB 72 kV 1200 A : 20kA	Unit	5.5	1	5.5	0.3	1	0.3	5.8
DS 72 kV 1200 A HOP	Set	0.8	3	2.4	0.1	3	0.3	2.7
OCB 15.5kV 2000 A : 40 kA	Unit	3.1	1	3.1	0.3	1	0.3	3.4
OCB 15.5kV 1200 A : 25 kA	Unit	2.2	3	6.6	0.2	3	0.6	7.2
DS 15.5kV 1200 A (2000 A)	Set	0.45	8	3.6	0.025	8	0.2	3.8
PD 69/3 kV : 110/3 kV	Unit	1.8	1	1.8	–	–	–	1.8
Arrester 84 kV	Set	1.9	1	1.9	–	–	–	1.9
D.C. Power source	Set	5.5	1	5.5	0.2	1	0.2	5.7
Steel structure	Set	3.9	1	3.9	–	–	–	3.9
Control board	Set	11.8	1	11.8	–	–	–	11.8
Insulator & Busbar	Lot	3.3	1	3.3	–	–	–	3.3
Control cable	Set	2.2	1	2.2	–	–	–	2.2
Miscellaneous Materials	Lot	7.3	1	7.3	1.4	1	1.4	8.7
Foundation Work	Set	3.4	1	3.4	5.5	1	5.5	8.9
Building	Set	–	–	–	10.0	1	10.0	10.0
Sub Total				130.2			24.8	155.0
Freight & Insurance				14.4			2.9	17.3
TOTAL				144.6			27.7	172.3

Note: F.C. ... Foreign currency
L.C. ... Local currency

Appendix 3 - 3 Details of Construction Cost of Substations

(Case: Trans increase 28 MVA 1 unit S.S.)

Unit : 10^6 ¥

Item	Unit	F.C. Portion			L.C. Portion			Total Cost
		Unit cost	Q'ty	Cost	Unit cost	Q'ty	Cost	
Transformer 28MVA 69/12.5 kV	Unit	67.9	1	67.9	6.0	1	6.0	73.9
OCB 72 kV 1200 A : 20kA	Unit	5.5	1	5.5	0.3	1	0.3	5.8
DS 72 kV 1200 A HOP	Set	0.8	3	2.4	0.1	3	0.3	2.7
Recloser 15.5 kV 1200 A	Unit	2.7	3	8.1	0.1	3	0.3	8.4
DS 15.5kV 1200 A (2000 A)	Set	0.45	10	4.5	0.03	10	0.3	4.8
Arrester 84 kV	Set	1.8	1	1.8	–	–	–	1.8
CT, 15.5kV 1200/5A	Set	0.2	9	1.8	–	–	–	1.8
Steel structure	Set	2.6	1	2.6	0.2	1	0.2	2.8
Control board								
Insulator & Busbar	Lot	2.8	1	2.8	–	–	–	2.8
Control cable	Set	1.8	1	1.8	–	–	–	1.8
Miscellaneous Material	Lot	3.0	1	3.0	0.4	1	0.4	3.4
Foundation Work	Set	2.2	1	2.2	2.8	1	2.8	5.0
Building								
Sub Total				104.4			10.6	115.0
Freight & Insurance				11.9			2.0	13.9
TOTAL				116.3			12.6	128.9

Note: F.C. ... Foreign currency
L.C. ... Local currency

Appendix 3 - 4 Details of Construction Cost of 69 kV Transmission Line

(Feria S.S. . . . Timbeque S.S.)

Unit : 10^6 ¥

Item	Unit	Unit Cost	Q'ty	Material F. C.	Material L. C.	Construction F. C.	Construction L. C.	F. C.	L. C.	Total
Wood Pole	Pc	0.1	92	9.2	–	6.6	4.3	15.8	4.3	20.1
Cross arm	Pc	1.68	1	1.68	–	0.3	0.3	1.98	0.3	2.28
Insulator assembly										
Tension type	Set	0.055	80	4.4	–	0.3	0.3	4.7	0.3	5.0
Suspension type	Set	0.039	260	10.14	–	0.8	0.7	10.94	0.7	11.64
Guy wire	Set	1.1	1	1.1	–	1.6	1.7	2.7	1.7	4.4
Conductor 240 mm^2 ACSR	Ton	0.6	30	18.0	–	6.0	4.1	24.0	4.1	28.1
Ground wire & Hardware	Set	1.6	1	1.6	–	0.9	0.9	2.5	0.9	3.4
Miscellaneous materials	Set	0.88	1	0.88	–	1.0	1.1	1.88	1.1	2.98
Temporary Facilities	Set	1.0	1	–	–	–	1.0	–	1.0	1.0
Sub Total				47.0		17.5	14.4	64.5	14.4	78.9
Freight & Insurance				5.5			1.5	5.5	1.5	7.0
GRAND TOTAL				52.5		17.5	15.9	70.0	15.9	85.9

Note: F.C. ... Foreign currency
L.C. ... Local currency

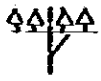
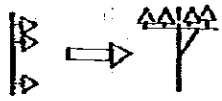
Appendix 3 - 5 Distribution Line Construction Cost

1. Basic Data

Conductor & Accessory

a.	Cu AWG 2/0	Conductor	1540 P/km	Connector	24 P/km
b.	Cu AWG 4/0	Conductor	2300 P/km	Connector	27 P/km
c.	ACSR 4/0	Conductor	980 P/km	Connector	32 P/km
d.	ACSR 266 kCM . . .	Conductor	1470 P/km	Connector	36 P/km

Support

Type	Description	Figure	Cost P/km
(B_1)	New feeder construction (1cct)		3266
(B_2)	Underbuilt 1 cct		1124
(B_3)	Change from single phase to three phase		462

2. New feeder Construction

Unit: P/km

Type	Conductor & Size	Conductor	Supporter	Total
3 Φ 4 W 1 cct	Cu 4/0 x 3 1/0 x 1	7950	3266	11216
	AC SR 266 kCM x 3 1/0 x 1	4578	3266	7844
3 Φ 4 W 2 cct	Cu 4/0 x 3 1/0 x 1	15900	4390	20290
	AC SR 266 kCM x 3 1/0 x 1	9156	4390	13546

Appendix 3 - 6 Construction Cost of Underground Lines

1. Design Conditions

   a. The Colonial district is the commercial center of the Santo Domingo City. Three (3) feeders – Merecedes, Padre Biilini and Independencia – which are now supplying electric power to there with 4 kV system voltage, should be boosted up to 12.5 kV and be laid in the underground.

   b. No. of feeders which supply to there should be increased to four (4) feeders from the existing three (3) feeders.

   c. In concideration of demand in ten years of future, the feeders should be designed

   c. In consideration of demand in ten years of future, the feeders should be designed to be capable to it.

   d. Manholes should be laid at park and/or road.

   e. Both H.V. and L.V. lines should be laid in underground (excepting lines in small alleys).

	Item	Q'ty	Unit	Unit cost ¥	Material 10^3 ¥	Construction 10^3 ¥
CONDUIT	F.R.P. 200 Φ	7,600	m	3,850	29,260	–
	Conduit rest upper	7,600	m	1,070	8,132	–
	Conduit rest lower	7,600	m	824	6,262	–
	Labour	7,600	m	25,390	–	–
MANHOLE	Manhole	37	Unit	400,000	14,800	192,964
	Ventilator	37	Unit	400,000	14,800	–
	Drain	37	Unit	100,000	3,700	–
	Fixture	37	Unit	100,000	3,700	–
	Labour	37	Unit	400,000	–	14,800
CABLE	Cable 15 kV 350 kCM	7,600	m	15,000	114,000	–
	Terminal treating material	37	Unit	320,000	11,840	–
	Prefablicated Joint kits	37	Unit	200,000	7,400	–

Item	Q'ty	Unit	Unit cost ¥	Material 10^3 ¥	Construction 10^3 ¥
Dispatched panel	37	Unit	1,000,000	37,000	–
Cable drawing	7,600	m	2,000	–	–
Labour	37	Unit	200,000	–	–
167.5 kVA	123	kVA Unit	418,000	51,414	–
50 kVA	72		175,000	12,600	–
Labour	195	Unit	50,000	–	9,750
Sub Total				314,908	240,114
Others				31,491	72,034
TOTAL				346,399	312,148

2. Detail of labour cost for conduit

Item	Unit cost	Q'ty	Cost (¥)
Concrete cutter	2,889 ¥/m	2m	5,778
Excavation	4,500 ¥/m^3	2.4 m^3	10,800
Back fill	2,724 ¥/m^3	2.16 m^3	5,884
Disposal of surplus soil	2,589 ¥/m^3	0.24 m^3	632
Sand	1,819 ¥/m^3	0.1 m^3	182
Asphalt	5,242 ¥/m^3	0.24 m^3	1,258
Concrete	8,560 ¥/m^3	0.1 m^3	856
TOTAL			25,390/M

Appendix 3 - 7 Construction Cost (Distribution Line)

Unit : 10^6 Yen (10^3 Peso)

		1st Stage			2nd Stage			3rd Stage			Total		
		F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
Underground Line	H.V. Distribution line	(1,452) 363	(1,312) 328	(2,764) 691							(1,452) 363	(1,312) 328	(2,764) 691
	L.V. Distribution line	(3,496) 874	(6,064) 1,516	(9,560) 2,390							(3,496) 874	(6,064) 1,516	(9,560) 2,390
	Sub Total [1]	(4,948) 1,237	(7,376) 1,844	(12,324) 3,081							(4,948) 1,237	(7,376) 1,844	(12,324) 3,081
Improvement for Loss reduction	Increase the voltage rating [2]	(784) 196	(209) 54	(993) 250							(784) 196	(209) 54	(993) 250
	Const. of New H.V.D. line [3]	(893) 223	(238) 60	(1,131) 283	(918) 230	(245) 61	(1,163) 291	(1,318) 330	(352) 88	(1,670) 418	(3,129) 783	(835) 209	(3,964) 992
	[4] [5] Size up & Change to 3-phase	(616) 154	(164) 41	(780) 195	(712) 178	(190) 48	(902) 226				(1,328) 332	(354) 89	(1,682) 421
	Improvement of Distribution Line in Slum area [6]	(1,577) 374	(421) 105	(1,998) 499	(3,780) 445	(475) 119	(2,255) 564				(3,357) 839	(895) 224	(4,253) 1,063
	L.V.D. Line Improvement [7]	(765) 191	(204) 51	(969) 242	(1,327) 332	(354) 89	(1,681) 421	(2,006) 502	(536) 134	(2,542) 636	(4,098) 1,025	(1,094) 274	(5,192) 1,299
	Sub Total [2 ~ 7]	(4,635) 1,158	(1,236) 311	(5,871) 1,469	(4,737) 1,185	(1,264) 317	(6,001) 1,502	(3,324) 832	(888) 222	(4,212) 1,054	(12,696) 3,175	(3,388) 850	(16,084) 4,025
Improvement of reliability	D. M. System [8]				(3,536) 884	(944) 236	(4,480) 1,120				(3,536) 884	(944) 236	(4,480) 1,120
	Lightning Arrester [9]				(1,439) 360	(384) 96	(1,823) 456	(1,836) 459	(490) 123	(2,326) 582	(3,275) 819	(874) 219	(4,149) 1,038
	Insulated Wire [10]				(167) 37	(39) 10	(156) 47	(188) 47	(50) 13	(238) 60	(335) 84	(87) 23	(424) 107
	Sub Total [8 ~ 10]				(5,122) 1,281	(1,367) 342	(6,459) 1,623	(2,024) 506	(540) 136	(2,564) 642	(7,146) 1,787	(1,907) 478	(9,053) 2,265
Tools & Instruments [11]		(800) 200		(800) 200				(1,180) 295		(1,180) 295	(1,980) 495		(1,980) 495
Total [1] ~ [11]		(10,383) 2,595	(8,612) 2,155	(18,995) 4,750	(9,859) 2,456	(2,631) 659	(12,490) 3,125	(6,528) 1,633	(1,428) 358	(7,956) 1,991	(26,770) 6,694	(12,671) 3,172	(39,441) 9,866

Figure in [ ] represent attachment numbers.

Note: F.C. ... Foreign currency
L.C. ... Local currency

Appendix 3- 8

Tools and Instruments

			Unit cost (A) ¥ 10^3	Number (B)	Total cost (A x B)
Oil Compression Tool	manual	8 ton	120		
	"	12 ton	160		
	motor drive	12 ton	450	20	9,000
	"	15 ton	570	30	17,100
Portable Generator	120V 1ϕ	1 kW	130		
	"	2 kW	300	5	1,500
	"	3 kW	390	5	1,950
	"	5 kW	500		
Vehicle	material transportation car		1,100	5	5,500
	field work car		5,400	10	54,000
	rudder car		7,000	3	21,000
	pole erection car		8,500	5	42,500
WHM Tester	120 V 1ϕ		5,000	1	5,000
	240 V 3ϕ		7,000	1	7,000
Sub. Total			—	—	164,550
Others					25,450
Grand Total					190,000

Appendix 4 Financial Statistics of CDE

Appendix 4 - 1 Assets and other Debts : Liabilities and Capital

NOV. 30–1979

Assets and other Debts		Liabilities and Capital	
Net Fixed Assets – Electric Utilitiy	164,869,326.62	Acting Capital	37,000,000.00
Net Fixed Assets – Others	343,137.92	Surplus of Credits	16,613,466.38
		Leagal reserve	15,998,746.42
Other Investment	1,045.00	Capital Total	69,612,242.80
Special Loan	2,159,983.17	Amortization reserve	2,805,000.00
Bills of Exchange	2,372,098.86	Debenture for Fuel	855,900.00
Provision for accumulated receivable electric charge	8,795,280.89	Long term Loan	129,640,121.57
Receivable Accounts	7,088,940.05	Advance Payment	11,553,538.12
Stock - pile	13,090,290.40	Consumers' Allotment	12,015,808.88
Advance charge	6,091.35	Interest	5,649,588.32
Current Assets	46,855,316.22	Other current Credits	4,891,416.96
		Subsidize for Construction	4,799,023.77
		Reserves	3,758,862.06
Grand Total	245,581,502.48		245,581,502.48

Appendix 4 - 2 Income Statement November, 1979

Fiscal year base

	As of this month	As of this month previous year
Operating Revenues	103,154,620.28	98,489,073.77
Operating Expenses		
Operation	92,371,101.43	77,724,536.60
Maintenance	4,897,577.23	3,945,488.96
Depreciation	5,735,290.96	5,535,382.83
Tax	4,004,935.45	3,558,645.52
Total Expenses	107,008,905.07	90,764,053.91
Balance	−3,854,284.79	7,725,019.86
Non-operating Revenue	765,650.27	154,654.70
Total Balance	−3,088,634.52	7,879,674.56
Deduction from total Balance		
Interest for Loan limited for 1985	15,675.00	15,675.00
- ditto - for 1987	138,600.00	138,600.00
Others' Interest	8,537,011.83	7,336,712.10
Member's Fee and its travel Cost	66,473.52	23,528.83
Deduction Total	8,757,760.35	7,514,515.93
Total Net Balance	−11,846,394.87	365,158.63
Extraordinary Expense	1,971,036.77	1,669,216.18
TOTAL	−13,817,431.64	−1,304,057.55
Carryover from the previous month	25,552,693.67	30,983,692.88
Carryover outstanding account	4,890,873.36	3,045,298.90
Total	16,626,135.39	31,994,610.85
Balance/Revenues (%)	−2.99	8.00
Net Balance/Revenue (%)	−11.48	0.37

Appendix 4 - 3 Total Generation Cost November 1979

Generation Plants Total

	This Year	Previous Year
Operation	55,622.0	50,062.4
Fuel	52,786.8	47,305.6
Maintenance	2,590.2	2,450.3
Managing expense	452.6	417.7
Boilers & Turbines	1,009.9	822.3
Diesel	307.0	305.4
Electrical Facilities Other equipment	440.3	372.2
Total Cost for Generation	69,945.3	58,192.7
Unit Cost for Generation (Centavo/kWh)	3.40	2.77
Generation (MWh)	1,738,089.3	1,913,156.7
Used energy at generating plants (MWh)	82,533.4	85,535.1
Net generation (MWh)	1,655,455.9	1,827,621.5
Purchase from others	400,308.0	270,311.9
Total sending end power (MWh)	2,055,753.9	2,097,933.4
Electric Energy Sales (MWh)	1,563,432.3	1,539,839.1
Loss	492,331.7	558,094.3
Ratio of Loss (%)	23.95	26.60
Maximum Peak Power (MW)	412.0	410.0
Load factor (%)	62.0%	64.0%

Appendix 4 - 4 Electric Utility Operating Revenues Statistics

November, 1979

	12 month moving total	
	This month	Previous year
Operating Revenues		
Residential	29,620,274.8	27,030,430.4
Commercial	13,465,813.9	12,276,131.4
Industrial	33,313,842.7	29,442,278.8
Public Illumination	1,602,663.4	1,455,833.9
Others	10,350,287.4	9,805,548.1
Total	88,352.882.3	80,010,222.8
Total Non-operating Revenues	14,801,737.9	18,478,850.9
Total Revenues	103,154,620.3	98,489,073.8
Electric Energy Sales		
Residential	581,568.4	583,466.9
Commercial	196,024.1	194,971.9
Industrial	602,026.8	573,638.2
Public Illumination	19,263.6	19,054.9
Others	162,185.3	166,672.6
Total	1,561,068.4	1,537,804.7
Unit Price for Sales (¢ /kWh) Yearly		
Residential	5.05	4.63
Commercial	6.81	6.30
Industrial	5.55	5.19

Appendix 5 : IRR calculation

Where; P_1 ····· Construction Cost for the first year

P_2 ····· Construction Cost for the second year

G_2 ····· Gain in the second year

G_3 ····· Gain in the third year

G_4 ····· Gain in the fourth year

After the fourth year,the effect of 2nd stage construction work will be superposed on the effect of the first stage construction work. So,every year's gain after the fourth year assumed same as G_4.

i ····· Interest rate for the Present worth factor computation.

Present worth of total construction cost

$$P_1\times 1/(1+i)+P_2\times 1/(1+i)^2 \cdots\cdots\cdots \underline{A}$$

Present worth of total gain

$$G_2\times 1/(1+i)^2+G_3\times 1/(1+i)^3+G_4\times 1/(1+i)^4+G_4\times 1/(1+i)^5$$
$$+\cdots\cdots+G_4\times 1/(1+i)^{25}$$
$$=G_2\times 1/(1+i)^2+G_3\times 1/(1+i)^3+G_4\times 1/(1+i)^4\times(1+i)/i\times$$
$$\{1-1/(1+i)^{22}\}$$

where, $1 > 1/(1+i)^{22}$

$$=G_2\times 1/(1+i)^2+G_3\times 1/(1+i)^3+G_4\times \frac{1}{i}\times \frac{1}{(1+i)^3} \cdots\cdots \underline{B}$$

Then, IRR will be calculated under the condition, $\underline{A}=\underline{B}$.

$$P_1 i^3+(2P_1+P_2-G_2)i^2+(P_1+P_2-G_2-G_3)i-G_4=0 \cdots\cdots\cdots\cdots \underline{C}$$

From Table 8-6, p-141,

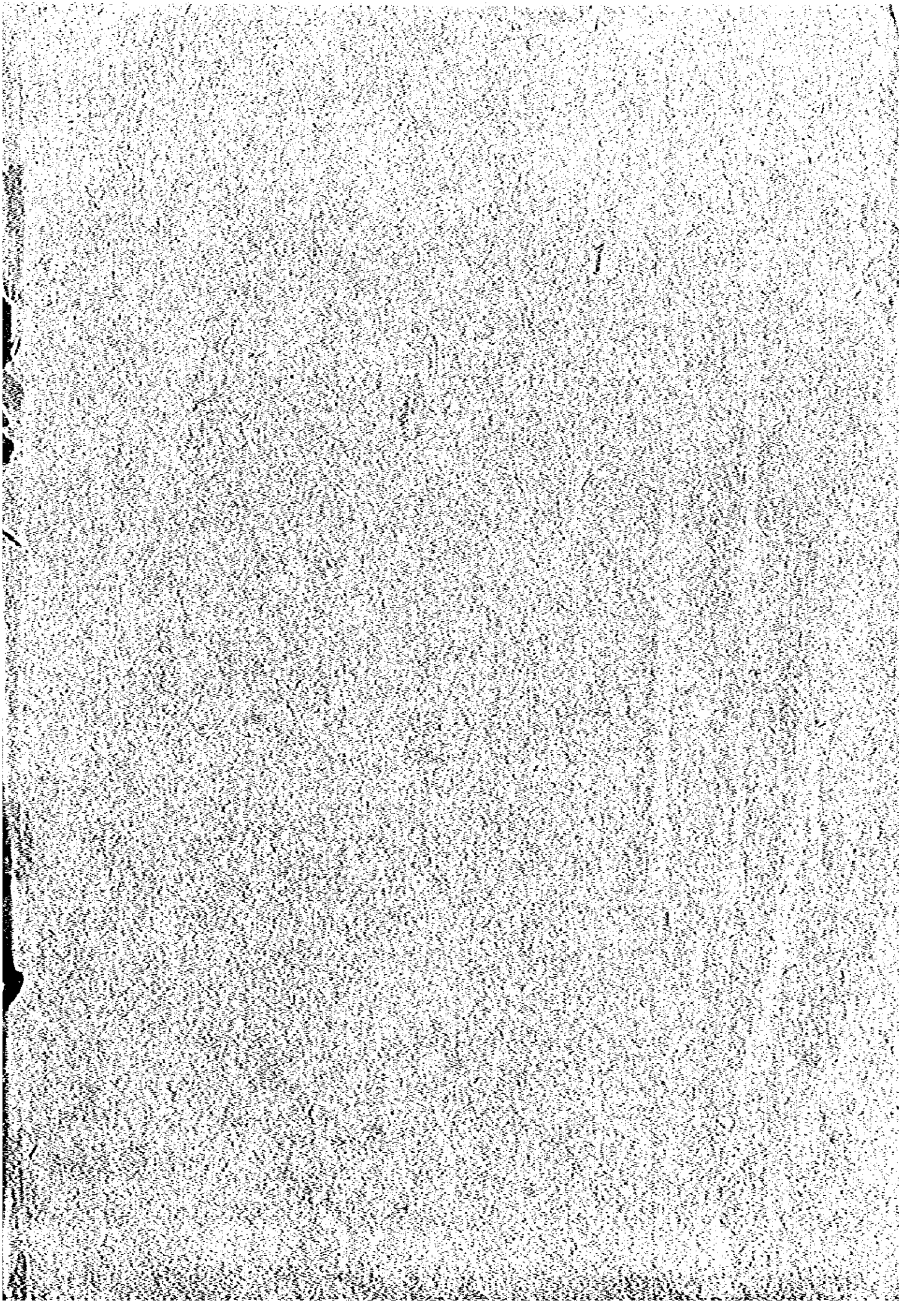
$P_1=5.0, P_2=24.7$, $G_2=10\times 0.32=3.2$, $G_3=14.4\times 0.32=4.6$, $G_4=17.7\times 0.32=5.7$,

Using these data,equation C becomes as follow,

$$5i^3+31.5i^2+21.9i-5.7=0$$

$i=0.2005$ and two complex numbers.

So, IRR is 20.05%



LA CONCEPCION

VILLAS NACO

LOS PERALEJOS

PRADERA REAL

ARROYO MULTANO

CUESTA BRAVO

CUESTA HERMOSA II

CERROS

LADERA DE Aᵐ HONDO

ALTOS DE Aᵐ HONDO III

NUEVO ARROYO HONDO

CUESTA HERMOSA

ALTOS DE Aᵐ HONDO II

ALAMEDA

VILLA PERAVIA

Km. 10

Km. 10½

LAS COLINAS

LOS RIOS

JARDIN BOTANICO NACIONAL DR RAFAEL M. MOSCOSO

LAS TRES AVENIDAS

STA CRUZ

SOSA CAMPOS

UNIVERSITARIA

TENIS CLUB

VILLA MARIA

LOS PROCERES

TRUEBA

LOS JARDINES

LAS CAOBAS

ENRIQUILLO

JUAN P. DUARTE

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BRISAS ALEGRES

LA HOYA DE LOS

BUENOS AIRES (DE HERRERA)

HERRERA

SAN GERONIMO

LA ENCARNACION

LOS PRADOS

LOS CEDROS D.T.C.C. OUISQUEYANO

PARAISO

MARRANZINI

LOS PRADITOS

LA CASTELLANA

EL PARQUE

JULIETA MORALES

CIUDAD MODERNA

CUESTA BRAVA
CUESTA HERMOSA II
CADERA DE A° HONDO
CERROS DE A° HONDO
NUEVO ARROYO HONDO
CUESTA HERMOSA I
ALTOS DE A° HONDO II
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ESSANCO
LOPERON
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Metropolitano
URB. ARTES
CO. ARTE
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VILLA CONSUELO
RIO OZAMA
RIO ISABELA
LA ZURZA
J.P. DUARTE
LOS MANGUITOS
LOS TRES BRAZOS
ENS. CAPOTILLO
GALICIA
SIMON BOLIVAR
EL ALGIBE
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GUALEY
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AGUA DUCT
SAN MARTIN DE PORRES
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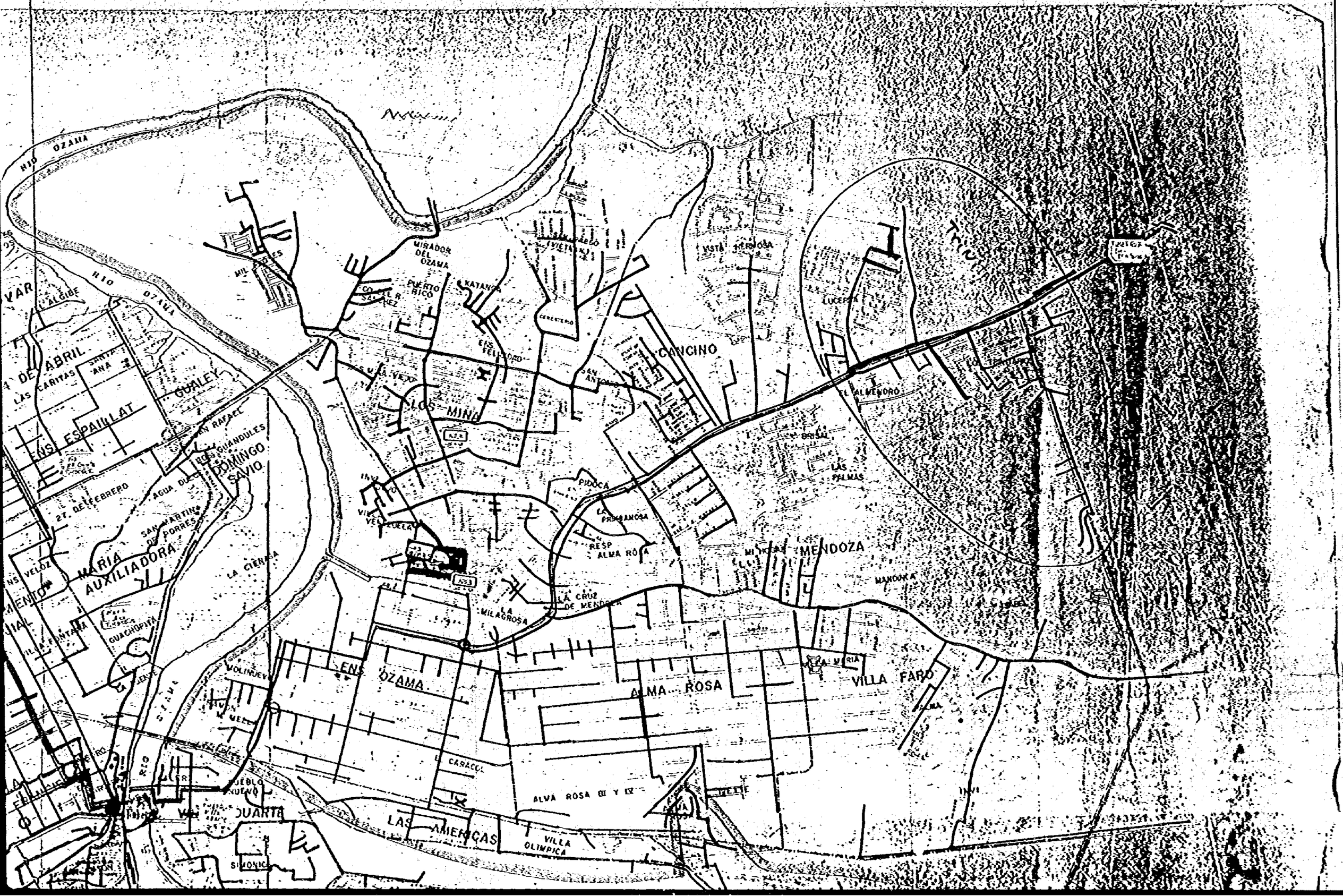
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LA MILAGROSA
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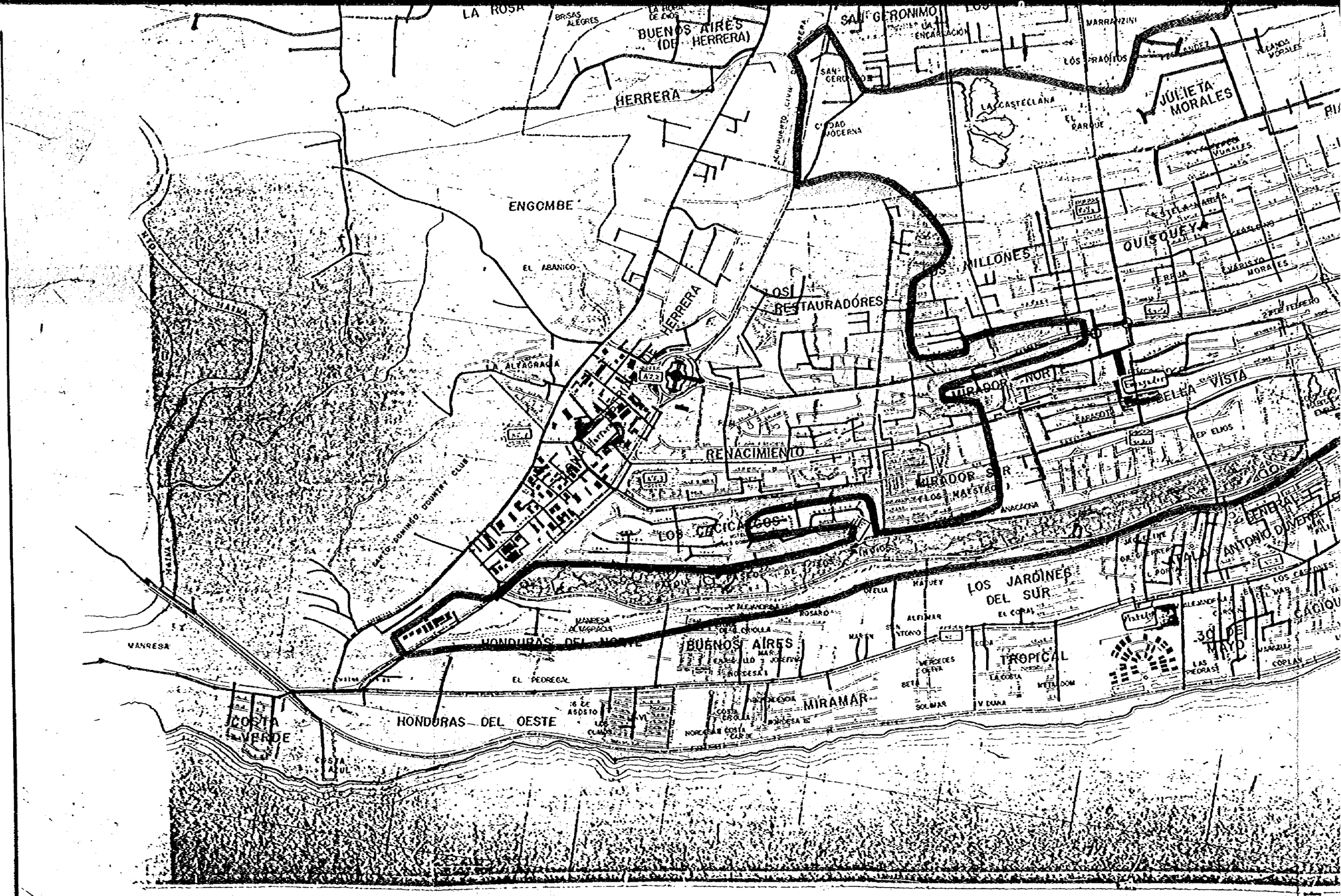
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LOS MOLINOS
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LAS PRECIAS
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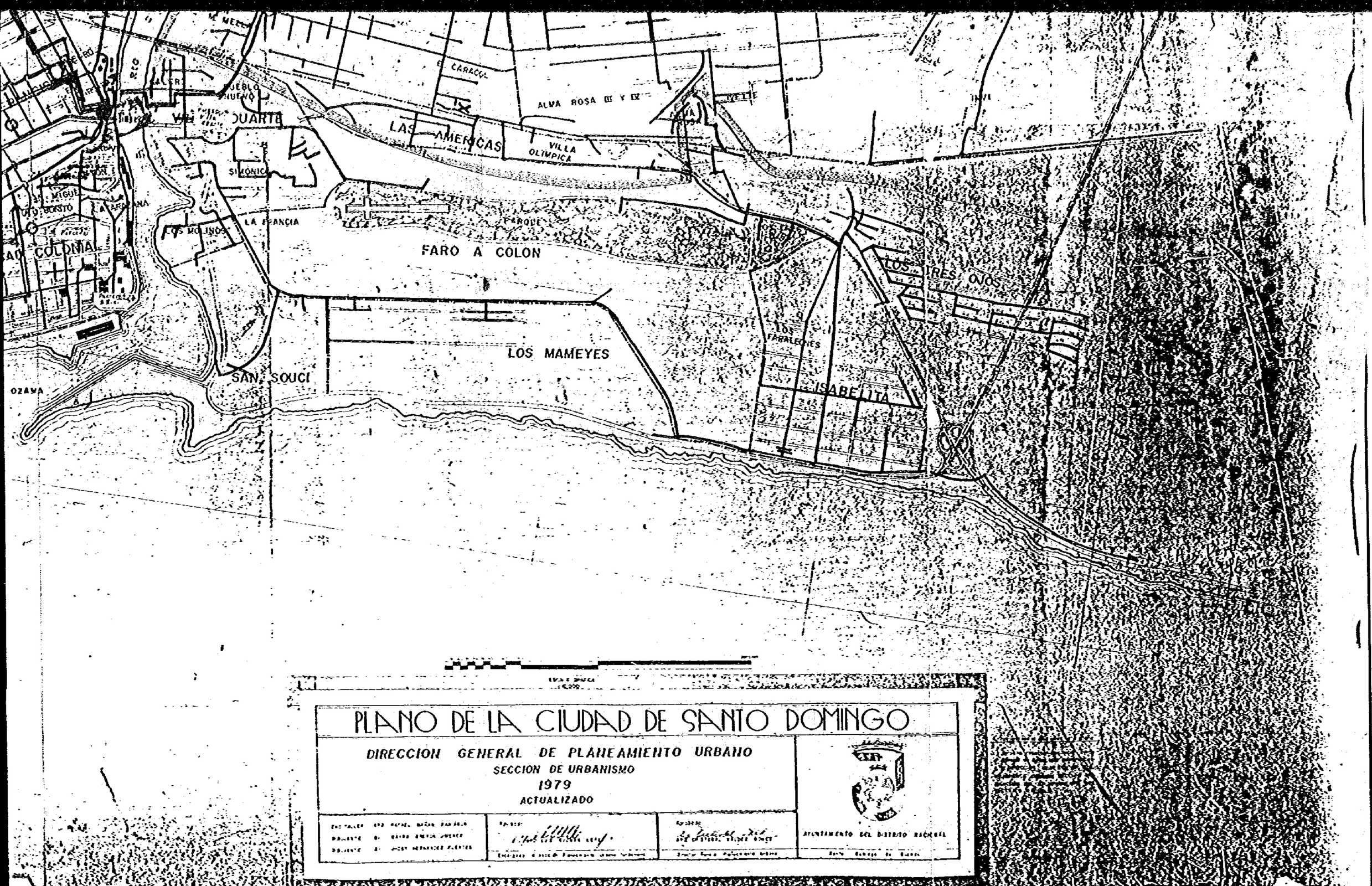
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