Annextures

Annex 5.1 Distribution Substation Expansion/Installation Plans

Distribution Substation Expansion/Installation Plans — Sheet No. 3

(1) Substation Capacity Enlargement

Table 1 Normal substation load limits

	Normal load limit
Banks	90%
Substations	85%
Blocks Prefectural capitals	90%
Other areas	90%

(2) Standards for Distribution Facilities (Midium-Voltage Edition)

Table 2 Standards for Midium-Voltage Distribution Facilities

- Substation bank capacities

The following final substation bank capacities are standard.

	Bank capacity
Large cities	8*3 - 8*3
Mid-sized cities, environs of large and mid-sized cities	8*3 - 8*3
Small cities, sub-prefectural areas	5*2 - 3.5*2

- Voltage and system

Voltage	11kV
Frequency	50Hz
System	Three-phase, three-wire rounded system

- High-voltage distribution line voltage drop limits

Voltage	11kV
Large and mid-sized cities	660V
Small cities and environs of large and mid-sized cities	660V
Sub-prefectural areas	660V

- Feeder systems and capacities

Feeder category	Load limit per circuit under normal distribution conditions	Load limit per circuit under power-interchange conditions
Large-capacity feeders	200A(150A)	200A(150A)
Medium-capacity feeders	200A(150A)	200A(150A)
Small-capacity feeders	200A(150A)	200A(150A)

(3) Planning Low Voltage Systems

a. Voltage and system

Table 3 Voltage ratings and Systems

Service category	Voltage and system
Light circuits	240V/415V single-phase, three-wire system
Power service	415V three-phase, three-wire system
Common use	240V/415V three-phase, four wire system

b. Service reliability

(a) Customer terminal voltage range

Table 4 Low voltage line voltage-fluctuation range

Terminal voltage range to be maintained

Customer load category	Customer terminal voltage range
Light circuits (240 V circuits)	Max. 240V, min. 200V
Power service (415 V circuits)	Max. 415V, min. 380V

(b)Low voltage line voltage drop limit

Table 5 Low voltage line voltage drop limits

Service category (Low voltage drop)	Limit
Light service (240V circuits)	+-20V
Power service (415V circuits)	+-40V

MEDAK ADE (+-10%) or LV +-9% HV +-6%

(4) Managing Load of Pole-mounted Transformers

Table 6 Overload limits with respect to the rated capacity of pole-mounted transformer

Transformer type	Banks under daytime (evening) peak load	Bank under nighttime peak load Load factor during daytime (evening) hours
Transformer powering lamp circuis	150%	----
Transformer powering lamp and motor circuis	150%	----
Transformer powering motor circuis	150% 120%(agriculture)	----

MEDAK ADE 150% Agriculture 120%

Annex 5.2 Sample of Measurement Results

Sample of measurement result (Voltage)

Meter Serial No.:APE13477
Measuring Item:
Transformer Sub Station: XII(Tarakarama Nagar)
Place of Measuring : Malkapur Sub Station, Malkapur Feeder.
Measuring Item: Voltage(V)

-1.0 indicates ALL POTENTIALS MISSING

DATE	0'o Clock	1'o Clock	2'o Clock	3'o Clock	4'o Clock	5'o Clock	6'o Clock	7'o Clock	8'o Clock	9'o Clock	10'o Clock	11'o Clock	12'o Clock	13'o Clock	14'o Clock	15'o Clock	16'o Clock	17'o Clock	18'o Clock	19'o Clock	20'o Clock	21'o Clock	22'o Clock	23'o Clock
1/8/2003	181.7	181.7	179.4	246.1	243.8	239.2	243.8	246.1	243.8	241.5	-1	-1	-1	-1	-1	-1	-1	-1	172.5	172.5	172.5	174.8	174.8	174.8
2/8/2003	181.7	181.7	181.7	250.7	250.7	246.1	253	253	248.4	243.8	-1	-1	-1	-1	-1	-1	-1	-1	-1	172.5	174.8	174.8	174.8	174.8
3/8/2003	177.1	177.1	177.1	174.8	172.5	170.2	-1	-1	-1	-1	246.1	246.1	243.8	248.4	241.5	241.5	246.1	-1	174.8	172.5	172.5	174.8	174.8	174.8
4/8/2003	174.8	177.1	174.8	172.5	170.2	167.9	-1	-1	-1	-1	239.2	239.2	239.2	246.1	246.1	243.8	246.1	-1	-1	188.6	181.7	181.7	184	181.7
5/8/2003	184	184	184	181.7	184	174.8	-1	-1	-1	-1	243.8	243.8	243.8	246.1	243.8	243.8	246.1	-1	193.2	172.5	174.8	174.8	177.1	174.8
6/8/2003	177.1	177.1	177.1	174.8	174.8	170.2	-1	-1	-1	-1	243.8	246.1	243.8	248.4	246.1	246.1	246.1	-1	174.8	170.2	172.5	174.8	174.8	174.8
7/8/2003	174.8	174.8	174.8	174.8	172.5	170.2	-1	-1	-1	-1	248.4	250.7	250.7	250.7	248.4	248.4	250.7	-1	197.8	188.6	177.1	174.8	177.1	177.1
8/8/2003	177.1	177.1	177.1	172.5	170.2	170.2	-1	-1	-1	-1	248.4	250.7	253	253	250.7	250.7	253	-1	177.1	174.8	172.5	174.8	174.8	174.8
9/8/2003	174.8	174.8	174.8	174.8	174.8	172.5	-1	-1	-1	-1	246.1	246.1	243.8	246.1	243.8	241.5	241.5	-1	174.8	172.5	172.5	174.8	177.1	174.8
10/8/2003	174.8	174.8	174.8	248.4	246.1	241.5	246.1	246.1	243.8	243.8	-1	-1	-1	-1	-1	-1	-1	-1	177.1	174.8	174.8	177.1	177.1	179.4
11/8/2003	174.8	177.1	177.1	257.6	255.3	253	243.8	241.5	239.2	239.2	181.7	165.6	-1	-1	-1	-1	-1	-1	-1	172.5	172.5	172.5	174.8	174.8
12/8/2003	174.8	174.8	174.8	248.4	243.8	243.8	241.5	241.5	234.6	230	-1	-1	-1	-1	-1	-1	-1	-1	174.8	170.2	174.8	172.5	174.8	174.8
13/08/2003	172.5	172.5	172.5	243.8	241.5	234.6	239.2	236.9	236.9	232.3	-1	-1	-1	-1	-1	-1	-1	-1	174.8	172.5	172.5	174.8	172.5	172.5
14/08/2003	172.5	174.8	174.8	243.8	241.5	236.9	239.2	241.5	239.2	234.6	-1	-1	-1	-1	-1	-1	-1	-1	172.5	170.2	170.2	174.8	174.8	174.8
15/08/2003	174.8	174.8	172.5	243.8	241.5	236.9	241.5	239.2	243.8	243.8	-1	-1	-1	-1	-1	-1	-1	-1	174.8	177.1	181.7	181.7	174.8	174.8
16/08/2003	174.8	174.8	174.8	241.5	241.5	239.2	239.2	239.2	234.6	234.6	-1	-1	-1	-1	-1	-1	-1	-1	-1	165.6	167.9	174.8	174.8	172.5
17/08/2003	172.5	172.5	170.2	174.8	167.9	165.6	-1	-1	-1	-1	232.3	232.3	230	232.3	234.6	236.9	234.6	-1	172.5	170.2	172.5	172.5	174.8	174.8
18/08/2003	174.8	174.8	174.8	170.2	167.9	163.3	-1	-1	-1	-1	234.6	234.6	232.3	234.6	230	230	236.9	-1	-1	167.9	172.5	172.5	174.8	177.1
19/08/2003	177.1	177.1	174.8	170.2	167.9	167.9	-1	-1	-1	-1	236.9	236.9	236.9	236.9	236.9	239.2	241.5	-1	177.1	177.1	193.2	195.5	195.5	193.2
20/08/2003	193.2	193.2	177.1	174.8	172.5	170.2	-1	-1	-1	-1	243.8	243.8	246.1	246.1	248.4	248.4	248.4	-1	167.9	172.5	174.8	174.8	177.1	177.1
21/08/2003	177.1	179.4	177.1	174.8	172.5	167.9	170.2	-1	-1	-1	253	255.3	259.9	255.3	250.7	250.7	250.7	-1	184	186.3	186.3	184	188.6	188.6
22/08/2003	188.6	186.3	186.3	181.7	179.4	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	241.5	243.8	243.8	248.4	253	253
23/08/2003	248.4	248.4	250.7	172.5	172.5	167.9	-1	-1	-1	-1	248.4	248.4	248.4	246.1	241.5	241.5	241.5	-1	190.9	188.6	188.6	190.9	190.9	193.2
24/08/2003	193.2	195.5	193.2	174.8	170.2	170.2	179.4	165.6	163.3	241.5	-1	-1	-1	-1	-1	-1	-1	-1	-1	188.6	188.6	190.9	190.9	190.9
25/08/2003	190.9	190.9	190.9	225.4	236.9	230	232.3	230	232.3	232.3	234.6	-1	-1	-1	-1	-1	-1	-1	165.6	170.2	165.6	186.3	186.3	188.6
26/08/2003	186.3	186.3	184	220.8	234.6	230	234.6	232.3	225.4	225.4	-1	-1	-1	-1	-1	-1	-1	-1	-1	161	161	163.3	165.6	165.6
27/08/2003	165.6	167.9	165.6	227.7	232.3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	216.2	220.8	232.3	227.7	230	174.8	170.2	167.9	167.9
28/08/2003	170.2	170.2	167.9	234.6	230	227.7	223.1	225.4	223.1	223.1	-1	-1	-1	-1	-1	-1	-1	-1	165.6	165.6	163.3	165.6	167.9	167.9
29/08/2003	170.2	170.2	167.9	230	230	223.1	220.8	223.1	223.1	218.5	-1	-1	-1	-1	-1	-1	-1	-1	163.3	170.2	163.3	170.2	167.9	170.2
30/08/2003	172.5	172.5	165.6	-1	227.7	220.8	218.5	218.5	213.9	216.2	-1	-1	-1	-1	-1	-1	-1	-1	161	158.7	161	163.3	165.6	165.6
31/08/2003	165.6	165.6	163.3	158.7	156.4	158.7	-1	-1	-1	-1	225.4	223.1	220.8	223.1	220.8	218.5	220.8	-1	-1	161	163.3	165.6	165.6	165.6
1/9/2003	167.9	167.9	165.6	158.7	158.7	156.4	156.4	-1	-1	-1	216.2	216.2	213.9	216.2	209.3	207	216.2	-1	156.4	158.7	158.7	158.7	163.3	165.6
2/9/2003	165.6	165.6	165.6	158.7	156.4	154.1	-1	-1	-1	-1	-1	-1	232.3	234.6	232.3	234.6	236.9	243.8	170.2	170.2	172.5	177.1	179.4	179.4
3/9/2003	179.4	179.4	181.7	172.5	167.9	165.6	-1	-1	-1	-1	241.5	239.2	239.2	236.9	239.2	239.2	241.5	243.8	179.4	177.1	177.1	174.8	177.1	177.1
4/9/2003	179.4	179.4	179.4	174.8	172.5	170.2	-1	-1	-1	-1	241.5	243.8	241.5	248.4	248.4	-1	-1	-1	-1	-1	-1	-1	-1	-1

LOAD SURVEY DATA FROM 01-08-03 TO 04-09-03, 35 DAYS

Sample of measurement result (Current)

Meter Serial No.:APE13477
Measuring Item:
Transformer Sub Station: XII(Tarakarama Nagar)
Place of Measuring : Malkapur Sub Station, Malkapur Feeder.
Measuring Item: Current (A)

-1.0 indicates ALL POTENTIALS MISSING

DATE	0'o Clock	1'o Clock	2'o Clock	3'o Clock	4'o Clock	5'o Clock	6'o Clock	7'o Clock	8'o Clock	9'o Clock	10'o Clock	11'o Clock	12'o Clock	13'o Clock	14'o Clock	15'o Clock	16'o Clock	17'o Clock	18'o Clock	19'o Clock	20'o Clock	21'o Clock	22'o Clock	23'o Clock
1/8/2003	48	48	44	172	164	160	156	120	116	112	-1	-1	-1	-1	-1	-1	-1	-1	60	100	116	88	88	76
2/8/2003	72	68	68	128	120	120	116	128	132	120	-1	-1	-1	-1	-1	-1	-1	-1	-1	104	116	100	68	64
3/8/2003	60	60	64	44	48	68	-1	-1	-1	-1	136	136	136	128	128	128	124	-1	32	112	108	88	80	76
4/8/2003	76	72	72	44	40	40	-1	-1	-1	-1	128	144	136	128	108	116	116	-1	-1	116	100	84	76	72
5/8/2003	72	68	72	64	40	44	-1	-1	-1	-1	116	112	112	112	108	120	116	-1	52	112	108	92	80	76
6/8/2003	76	76	76	40	40	52	-1	-1	-1	-1	112	108	104	104	100	100	108	-1	32	112	112	96	84	80
7/8/2003	80	76	76	44	48	56	-1	-1	-1	-1	88	92	92	92	92	84	84	-1	32	92	104	96	84	80
8/8/2003	80	80	76	44	40	40	-1	-1	-1	-1	92	104	104	112	116	116	108	-1	32	100	124	108	96	92
9/8/2003	88	88	88	40	40	48	-1	-1	-1	-1	120	112	124	116	124	128	128	-1	36	124	128	112	100	96
10/8/2003	92	92	92	156	144	136	120	128	136	132	-1	-1	-1	-1	-1	-1	-1	-1	40	112	120	104	88	88
11/8/2003	84	84	84	12	0	0	144	156	164	144	32	44	-1	-1	-1	-1	-1	-1	-1	112	120	116	104	100
12/8/2003	100	84	84	164	152	156	152	160	188	192	-1	-1	-1	-1	-1	-1	-1	-1	40	136	136	120	100	100
13/08/2003	100	100	96	168	148	160	180	184	184	164	-1	-1	-1	-1	-1	-1	-1	-1	44	128	132	120	100	100
14/08/2003	96	72	72	168	148	160	160	156	164	164	-1	-1	-1	-1	-1	-1	-1	-1	36	120	120	108	92	88
15/08/2003	84	84	84	156	148	160	176	172	160	144	-1	-1	-1	-1	-1	-1	-1	-1	52	100	108	84	72	68
16/08/2003	64	64	64	168	156	156	156	164	176	176	-1	-1	-1	-1	-1	-1	-1	-1	-1	132	120	76	76	72
17/08/2003	84	84	84	52	56	80	-1	-1	-1	-1	172	160	180	188	188	172	160	-1	56	116	120	108	92	88
18/08/2003	88	88	84	68	84	88	-1	-1	-1	-1	152	156	164	176	176	168	168	-1	-1	128	120	108	108	100
19/08/2003	100	100	100	68	68	68	-1	-1	-1	-1	172	164	136	136	148	136	132	-1	52	116	112	80	68	64
20/08/2003	64	64	68	56	56	72	-1	-1	-1	-1	132	128	120	116	112	136	120	-1	60	104	108	80	84	84
21/08/2003	84	84	84	48	64	80	72	-1	-1	-1	112	108	100	96	96	96	96	-1	48	76	68	56	44	40
22/08/2003	40	40	40	40	40	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	124	132	116	100	96	96
23/08/2003	96	96	96	32	32	36	-1	-1	-1	-1	88	76	84	108	108	116	116	-1	56	72	68	48	40	36
24/08/2003	32	32	32	32	32	36	40	56	48	120	-1	-1	-1	-1	-1	-1	-1	-1	-1	88	84	56	44	40
25/08/2003	40	40	40	112	132	136	124	148	116	124	116	-1	-1	-1	-1	-1	-1	-1	24	88	96	68	56	56
26/08/2003	52	52	52	96	112	132	128	128	148	144	-1	-1	-1	-1	-1	-1	-1	-1	-1	108	116	96	84	84
27/08/2003	80	80	80	152	164	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	164	184	168	176	192	80	68	48	44
28/08/2003	44	44	44	164	160	160	152	148	152	164	-1	-1	-1	-1	-1	-1	-1	-1	56	96	92	76	64	60
29/08/2003	60	56	56	160	152	172	176	172	168	180	-1	-1	-1	-1	-1	-1	-1	-1	40	100	108	88	84	64
30/08/2003	64	68	76	-1	188	192	176	184	188	180	-1	-1	-1	-1	-1	-1	-1	-1	56	112	116	100	76	84
31/08/2003	84	80	80	64	64	84	-1	-1	-1	-1	180	188	184	188	164	176	180	-1	-1	116	116	100	84	68
1/9/2003	52	48	52	52	64	60	60	-1	-1	-1	168	180	172	172	192	152	168	-1	104	120	112	100	88	84
2/9/2003	84	84	84	64	72	60	-1	-1	-1	-1	-1	-1	196	204	188	192	172	156	80	136	136	124	76	68
3/9/2003	68	64	64	48	72	64	-1	-1	-1	-1	160	160	160	180	176	164	156	144	80	132	136	120	104	100
4/9/2003	100	96	96	48	56	68	-1	-1	-1	-1	196	188	200	176	152	-1	-1	-1	-1	-1	-1	-1	-1	-1

LOAD SURVEY DATA FROM 01-08-03 TO 04-09-03, 35 DAYS

Sample of measurement result (kW)

Meter Serial No.:APE13477
Measuring Item:
Transformer Sub Station: XII(Tarakarama Nagar)
Place of Measuring : Malkapur Sub Station, Malkapur Feeder.
Measuring Item: KW(KW)

-1.0 indicates ALL POTENTIALS MISSING

DATE	0'o Clock	1'o Clock	2'o Clock	3'o Clock	4'o Clock	5'o Clock	6'o Clock	7'o Clock	8'o Clock	9'o Clock	10'o Clock	11'o Clock	12'o Clock	13'o Clock	14'o Clock	15'o Clock	16'o Clock	17'o Clock	18'o Clock	19'o Clock	20'o Clock	21'o Clock	22'o Clock	23'o Clock
1/8/2003	12.6	12.6	12.6	103.2	94.8	91.8	93.6	70.8	67.2	67.2									1.2	28.2	36	26.4	27.6	21
2/8/2003	19.2	18.6	18.6	70.2	64.2	63	67.8	72	79.8	70.8										30.6	34.8	31.2	21	19.2
3/8/2003	19.2	19.2	19.8	5.4	12.6	17.4					82.8	83.4	80.4	76.8	76.2	75.6	74.4		0.6	33	33	27.6	25.8	25.2
4/8/2003	25.2	24.6	24	11.4	11.4	9					78.6	90	82.2	76.2	64.2	68.4	70.8			34.8	30	24.6	22.2	22.2
5/8/2003	21.6	21.6	21.6	18	12	13.8					67.8	68.4	69	67.8	66	70.8	68.4		1.2	33.6	33.6	29.4	27	25.8
6/8/2003	25.8	25.2	25.2	11.4	10.8	15					52.8	64.8	61.8	63.6	59.4	58.8	66		0.6	32.4	33.6	30	26.4	25.8
7/8/2003	25.2	25.2	24.6	11.4	13.8	16.8					49.8	53.4	53.4	54.6	54.6	47.4	46.2		1.2	27	31.8	30	27.6	26.4
8/8/2003	26.4	26.4	25.2	9	11.4	10.8					52.8	61.8	63	67.8	64.2	71.4	55.8		0.6	28.8	39	34.8	31.2	31.2
9/8/2003	30	30	30	9	10.8	12					73.2	69.6	74.4	70.8	76.8	76.8	76.2		1.2	39	39.6	36	34.8	33
10/8/2003	31.8	32.4	32.4	82.8	80.4	72.6	72	79.2	84.6	81									3	34.2	35.4	31.8	29.4	28.8
11/8/2003	27.6	27	27	6.6	3	0.6	87	97.8	101.4	87.6	11.4	15								33.6	36	36.6	33.6	33
12/8/2003	33	27.6	27	89.4	79.2	85.8	90	96.6	114	112.8									0.6	40.8	42.6	37.8	33.6	33
13/08/2003	32.4	33	31.8	92.4	81	89.4	108	112.2	111.6	100.2									1.8	39.6	40.8	37.8	33	31.8
14/08/2003	30.6	19.2	18.6	97.8	82.8	89.4	97.8	97.2	99.6	99.6									0.6	34.2	34.8	32.4	28.2	27
15/08/2003	27	27	25.8	85.2	80.4	88.8	105.6	104.4	100.2	87									1.8	30	29.4	25.2	21.6	21
16/08/2003	20.4	20.4	19.8	89.4	90	83.4	93.6	100.2	106.2	107.4										37.2	34.2	20.4	22.2	20.4
17/08/2003	25.2	24.6	25.2	15.6	16.2	24.6					103.2	93.6	106.2	110.4	111.6	49.2	96.6		0.6	34.8	34.8	32.4	28.8	27.6
18/08/2003	27.6	27.6	26.4	18.6	24.6	25.2					87.6	93.6	97.2	105.6	104.4	100.8	103.8			33	35.4	33.6	34.2	33.6
19/08/2003	33.6	33.6	32.4	18	19.2	19.8					85.8	102	84	82.8	90.6	82.8	76.2		1.2	34.8	30	21.6	18	17.4
20/08/2003	17.4	16.8	18.6	14.4	15.6	4.2					78	76.2	71.4	55.2	67.8	68.4	73.2		3.6	29.4	32.4	23.4	27.6	27.6
21/08/2003	27.6	27.6	27	12.6	19.2	24	13.8				39	63	57	56.4	55.2	56.4	54		0.6	21	18	15	12	12
22/08/2003	11.4	12	11.4	7.2	10.8														27	57.6	57	53.4	52.2	52.8
23/08/2003	51.6	52.2	51.6	8.4	8.4	9					46.2	38.4	20.4	63	58.2	66.6	65.4		1.8	18.6	17.4	12.6	10.2	9.6
24/08/2003	9	9	8.4	7.8	8.4	10.2	12.6	18	14.4	62.4										22.2	22.2	13.8	11.4	10.8
25/08/2003	10.8	10.8	10.2	53.4	71.4	75	70.8	85.2	66	71.4	22.8								0	25.2	28.8	17.4	14.4	13.8
26/08/2003	13.8	13.2	13.2	43.2	58.8	70.2	73.2	76.2	85.2	75.6										28.2	31.2	27.6	25.2	25.2
27/08/2003	25.2	25.2	24	75	91.8											90	103.2	97.8	93.6	96.6	20.4	16.8	12.6	12
28/08/2003	12	11.4	11.4	91.2	88.8	87.6	85.2	84	84.6	94.8									1.8	26.4	25.8	21.6	18.6	18
29/08/2003	18	18	18	84.6	84.6	92.4	96.6	98.4	96.6	102.6									0	24.6	31.2	24.6	24	16.2
30/08/2003	15.6	18.6	22.8		105	104.4	97.2	101.4	102.6	99									0.6	30.6	31.8	28.8	21.6	25.2
31/08/2003	24.6	24	24	17.4	16.8	24					101.4	106.8	104.4	106.8	39	97.8	42			31.2	31.8	27.6	24.6	19.2
1/9/2003	12	12.6	12.6	4.8	17.4	16.2	0				86.4	99.6	91.2	95.4	105	68.4	92.4		2.4	32.4	30.6	28.2	25.8	25.8
2/9/2003	25.2	25.2	25.2	16.2	19.8	16.2							85.8	121.2	108.6	114	96	14.4	6.6	42	41.4	37.2	20.4	18
3/9/2003	18	17.4	16.8	13.2	19.8	19.2					87.6	98.4	97.2	94.2	105.6	97.8	92.4	14.4	0.6	42.6	42.6	39	35.4	33.6
4/9/2003	33.6	34.2	33.6	13.2	17.4	21.6					88.8	117.6	125.4	110.4	91.8									

LOAD SURVEY DATA FROM 01-08-03 TO 04-09-03, 35 DAYS

Sample of measurement result (PF)

Meter Serial No.:APE13477
Measuring Item:
Transformer Sub Station: XII(Tarakarama Nagar)
Place of Measuring : Malkapur Sub Station, Malkapur Feeder.
Measuring Item: PF (PF%)

-1.0 indicates ALL POTENTIALS MISSING

DATE	0'o Clock	1'o Clock	2'o Clock	3'o Clock	4'o Clock	5'o Clock	6'o Clock	7'o Clock	8'o Clock	9'o Clock	10'o Clock	11'o Clock	12'o Clock	13'o Clock	14'o Clock	15'o Clock	16'o Clock	17'o Clock	18'o Clock	19'o Clock	20'o Clock	21'o Clock	22'o Clock	23'o Clock
1/8/2003	0.955	0.955	1	0.891	0.893	0.89	0.881	0.843	0.848	0.848	-2	-2	-2	-2	-2	-2	-2	-2	0.667	1	1	1	0.979	1
2/8/2003	0.941	0.939	0.969	0.86	0.843	0.847	0.831	0.839	0.858	0.849	-2	-2	-2	-2	-2	-2	-2	-2	-2	1	0.983	1	1	0.941
3/8/2003	1	1	0.971	1	1	0.967	-2	-2	-2	-2	0.862	0.863	0.832	0.848	0.852	0.851	0.838	-2	1	0.982	0.982	0.979	1	1
4/8/2003	1	1	0.976	1	1	1	-2	-2	-2	-2	0.879	0.893	0.884	0.847	0.849	0.864	0.868	-2	-2	0.951	0.962	0.953	0.925	0.949
5/8/2003	0.923	0.973	0.947	0.938	1	1	-2	-2	-2	-2	0.876	0.864	0.865	0.85	0.853	0.849	0.851	-2	1	1	1	1	1	1
6/8/2003	1	0.977	1	0.95	0.947	1	-2	-2	-2	-2	0.88	0.844	0.858	0.841	0.853	0.845	0.853	-2	1	0.964	0.982	1	1	1
7/8/2003	0.977	1	0.976	1	1	0.966	-2	-2	-2	-2	0.838	0.84	0.824	0.827	0.835	0.814	0.802	-2	1	1	1	1	1	1
8/8/2003	1	1	0.977	1	1	1	-2	-2	-2	-2	0.83	0.831	0.84	0.837	0.849	0.838	0.823	-2	1	0.98	0.985	1	0.981	1
9/8/2003	0.98	1	0.98	0.938	0.947	0.952	-2	-2	-2	-2	0.878	0.866	0.867	0.861	0.871	0.871	0.858	-2	1	0.985	0.985	0.984	1	0.982
10/8/2003	0.981	1	1	0.896	0.876	0.877	0.863	0.863	0.87	0.854	-2	-2	-2	-2	-2	-2	-2	-2	1	0.983	0.983	0.981	1	1
11/8/2003	0.979	0.978	1	0.846	1	1	0.895	0.901	0.889	0.896	1	1	-2	-2	-2	-2	-2	-2	-2	0.982	1	1	1	1
12/8/2003	1	1	0.978	0.903	0.904	0.899	0.893	0.89	0.896	0.883	-2	-2	-2	-2	-2	-2	-2	-2	0.5	0.986	1	0.984	1	0.982
13/08/2003	0.964	1	0.964	0.885	0.871	0.887	0.896	0.886	0.882	0.898	-2	-2	-2	-2	-2	-2	-2	-2	1	0.985	0.986	0.984	0.982	0.981
14/08/2003	0.981	0.97	0.939	0.896	0.879	0.892	0.896	0.89	0.888	0.883	-2	-2	-2	-2	-2	-2	-2	-2	1	0.983	0.983	0.982	0.979	0.978
15/08/2003	0.978	1	0.977	0.877	0.87	0.892	0.889	0.883	0.888	0.868	-2	-2	-2	-2	-2	-2	-2	-2	1	1	0.961	0.977	1	1
16/08/2003	1	1	0.971	0.898	0.904	0.897	0.891	0.893	0.898	0.891	-2	-2	-2	-2	-2	-2	-2	-2	-2	0.939	1	1	1	0.971
17/08/2003	0.977	0.953	1	0.963	1	1	-2	-2	-2	-2	0.891	0.891	0.889	0.885	0.89	0.891	0.89	-2	1	0.983	0.967	1	1	0.979
18/08/2003	0.979	0.979	0.978	0.969	0.976	0.977	-2	-2	-2	-2	0.89	0.886	0.88	0.88	0.883	0.889	0.892	-2	-2	0.965	0.983	0.982	0.983	0.982
19/08/2003	1	0.982	0.982	1	1	1	-2	-2	-2	-2	0.888	0.89	0.875	0.873	0.878	0.89	0.882	-2	1	0.983	0.962	0.973	0.938	0.967
20/08/2003	0.967	0.966	1	1	1	1	-2	-2	-2	-2	0.867	0.876	0.869	0.868	0.85	0.87	0.847	-2	1	1	1	1	1	1
21/08/2003	1	1	0.978	0.955	1	1	0.958	-2	-2	-2	0.844	0.833	0.812	0.825	0.821	0.832	0.818	-2	1	1	0.968	1	1	1
22/08/2003	0.95	1	0.95	1	0.947	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0.9	0.881	0.872	0.856	0.845	0.846
23/08/2003	0.843	0.853	0.843	1	1	0.938	-2	-2	-2	-2	0.837	0.81	0.85	0.847	0.874	0.854	0.845	-2	1	1	1	1	1	0.941
24/08/2003	1	0.938	0.933	1	1	0.944	0.955	0.968	0.923	0.881	-2	-2	-2	-2	-2	-2	-2	-2	-2	0.974	0.974	0.958	1	1
25/08/2003	1	1	1	0.89	0.875	0.887	0.874	0.866	0.853	0.856	0.884	-2	-2	-2	-2	-2	-2	-2	-2	0.977	1	1	1	0.958
26/08/2003	0.958	0.957	1	0.867	0.875	0.88	0.878	0.882	0.882	0.881	-2	-2	-2	-2	-2	-2	-2	-2	-2	0.979	0.963	0.958	0.977	1
27/08/2003	1	1	0.976	0.893	0.905	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0.888	0.882	0.881	0.891	0.899	1	0.966	1	1
28/08/2003	1	1	1	0.879	0.886	0.89	0.882	0.881	0.87	0.883	-2	-2	-2	-2	-2	-2	-2	-2	1	0.978	1	1	0.969	1
29/08/2003	1	1	1	0.898	0.892	0.895	0.89	0.891	0.88	0.881	-2	-2	-2	-2	-2	-2	-2	-2	0	0.976	0.981	0.953	0.93	0.964
30/08/2003	0.929	0.969	0.974	-2	0.888	0.888	0.885	0.885	0.877	0.887	-2	-2	-2	-2	-2	-2	-2	-2	1	0.981	1	0.98	0.973	1
31/08/2003	0.976	0.976	0.976	1	0.966	1	-2	-2	-2	-2	0.88	0.886	0.888	0.881	0.878	0.886	0.886	-2	-2	0.963	0.981	0.958	0.953	0.97
1/9/2003	0.952	0.955	0.955	1	0.967	1	0	-2	-2	-2	0.878	0.878	0.884	0.874	0.884	0.877	0.87	-2	1	0.964	0.962	0.979	1	1
2/9/2003	0.977	0.977	0.977	1	1	0.964	-2	-2	-2	-2	-2	-2	0.888	0.886	0.879	0.884	0.87	0.889	0.917	0.986	0.986	0.954	0.971	0.938
3/9/2003	0.968	0.967	1	1	0.971	1	-2	-2	-2	-2	0.869	0.877	0.871	0.882	0.876	0.872	0.87	0.889	1	1	0.986	1	1	1
4/9/2003	0.982	1	1	1	1	1	-2	-2	-2	-2	0.886	0.883	0.889	0.876	0.86	-2	-2	-2	-2	-2	-2	-2	-2	-2

LOAD SURVEY DATA FROM 01-08-03 TO 04-09-03, 35 DAYS

Sample of measurement result (MAX kW)

Meter Serial No.:APE13477
Transformer Sub Station: XII (Tarakarama Nagar)
Mouth of Feeder: Malkapur
Place of Measuring : Malkapur Sub Station, Malkapur Feeder.
Measuring Item: Max kW(kW)

DATE	August	September
1	103.2	105
2	79.8	121.2
3	83.4	105.6
4	90	125.4
5	70.8	
6	66	
7	54.6	
8	71.4	
9	76.8	
10	84.6	
11	101.4	
12	114	
13	112.2	
14	99.6	
15	105.6	
16	107.4	
17	111.6	
18	105.6	
19	102	
20	78	
21	63	
22	57.6	
23	66.6	
24	62.4	
25	85.2	
26	85.2	
27	103.2	
28	94.8	
29	102.6	
30	105	
31	106.8	

LOAD SURVEY DATA FROM 01-08-03 TO 04-09-03, 35 DAYS

Sample of measurement result (kWh)

Meter Serial No.:APE13477
Mouth of Feeder: Malkapur
Transformer Sub Station: XII (Tarakarama Nagar)
Place of Measuring : Malkapur Sub Station, Malkapur Feeder.
Measuring Item: Max kWH (kWH)

DATE	August	September
1	115.8	118.8
2	93	136.8
3	96.6	120.6
4	100.8	141
5	83.4	
6	77.4	
7	66	
8	85.2	
9	88.8	
10	97.2	
11	114	
12	127.8	
13	126.6	
14	112.8	
15	118.8	
16	120.6	
17	125.4	
18	120	
19	114.6	
20	90	
21	75.6	
22	65.4	
23	78	
24	70.8	
25	98.4	
26	96.6	
27	117	
28	107.4	
29	116.4	
30	118.2	
31	121.2	

LOAD SURVEY DATA FROM 01-08-03 TO 04-09-03, 35 DAYS

Sample of measurement result (Customer kWh)

Measuring item (facility wide) Sheet No. 1 -19
Customer (Including agricultural customer)
Place of Measuring (Malkapur Sub Station Malkapur Feeder)
measuring item Max KW(KW)
YY 2000

Sl. No.	Name of transformer	Customer No.	Category	July					July				
				Reading	date of measuring	Reading	date of measuring	Consumption	Reading	date of measuring	Reading	date of measuring	Consumption
1	SS XII Village T/F	876	Residential	56	2003/7/23	61	2003/7/30	5	72	2003/8/23	80	2003/8/30	8
2	SS XII Village T/F	759	Residential	344	2003/7/23	349	2003/7/30	5	366	2003/8/23	376	2003/8/30	10
3	SS XII Village T/F	498	Residential	1235	2003/7/23	1241	2003/7/30	6	1257	2003/8/23	1262	2003/8/30	5
4	SS XII Village T/F	679	Residential	194	2003/7/23	200	2003/7/30	6	222	2003/8/23	228	2003/8/30	6
5	SS XII Village T/F	683	Residential	460	2003/7/23	468	2003/7/30	8	497	2003/8/23	499	2003/8/30	2
6	SS XII Village T/F	783	Residential	7	2003/7/23	7	2003/7/30	0	7	2003/8/23	7	2003/8/30	0
7	SS XII Village T/F	782	Residential	61	2003/7/23	67	2003/7/30	6	87	2003/8/23	93	2003/8/30	6
8	SS XII Village T/F	692	Residential	951	2003/7/23	956	2003/7/30	5	364	2003/8/23	368	2003/8/30	4
9	SS XII Village T/F	566	Residential	2480	2003/7/23	2496	2003/7/30	16	25030	2003/8/23	25038	2003/8/30	8
10	SS XII Village T/F	571	Residential	4378	2003/7/23	4386	2003/7/30	8	4417	2003/8/23	4420	2003/8/30	3
11	SS XII Village T/F	638	Residential	1183	2003/7/23	1192	2003/7/30	9	1208	2003/8/23	1212	2003/8/30	4
12	SS XII Village T/F	582	Residential	442	2003/7/23	455	2003/7/30	13	495	2003/8/23	507	2003/8/30	12
13	SS XII Village T/F	648	Residential	869	2003/7/23	874	2003/7/30	5	874	2003/8/23	884	2003/8/30	10
14	SS XII Village T/F	684	Residential	612	2003/7/23	623	2003/7/30	11	657	2003/8/23	670	2003/8/30	13
15	SS XII Village T/F	667	Residential	462	2003/7/23	467	2003/7/30	5	485	2003/8/23	491	2003/8/30	6
16	SS XII Village T/F	857	Residential	726	2003/7/23	734	2003/7/30	8	765	2003/8/23	773	2003/8/30	8
17	SS XII Village T/F	718	Residential	739	2003/7/23	742	2003/7/30	3	750	2003/8/23	754	2003/8/30	4
18	SS XII Village T/F	625	Residential	938	2003/7/23	948	2003/7/30	10	978	2003/8/23	983	2003/8/30	5
19	SS XII Village T/F	729	Residential	323	2003/7/23	326	2003/7/30	3	342	2003/8/23	346	2003/8/30	4
20	SS XII Village T/F	628	Residential	856	2003/7/23	961	2003/7/30	105	874	2003/8/23	879	2003/8/30	5
21	SS XII Village T/F	671	Residential	2099	2003/7/23	2105	2003/7/30	6	2185	2003/8/23	2189	2003/8/30	4
22	SS XII Village T/F	652	Residential	477	2003/7/23	489	2003/7/30	12	500	2003/8/23	504	2003/8/30	4
23	SS XII Village T/F	215	Residential	4381	2003/7/23	4395	2003/7/30	14	4399	2003/8/23	4409	2003/8/30	10
24	SS XII Village T/F	460	Residential	1848	2003/7/23	1856	2003/7/31	8	1892	2003/8/23	1898	2003/8/30	6
25	SS XII Village T/F	125	Residential	482	2003/7/23	494	2003/7/30	12	530	2003/8/23	539	2003/8/30	9
26	SS XII Village T/F	789	Residential	2234	2003/7/23	2246	2003/7/30	12	2270	2003/8/23	2275	2003/8/30	5
27	SS XII Village T/F	788	Residential	883	2003/7/23	899	2003/7/31	16	910	2003/8/23	915	2003/8/30	5
28	SS XII Village T/F	499	Residential	2246	2003/7/23	2286	2003/7/30	40	2299	2003/8/23	2308	2003/8/30	9
29	SS XII Village T/F	137	Residential	6714	2003/7/23	6714	2003/7/31	0	6714	2003/8/23	6714	2003/8/30	0
30	SS XII Village T/F	468	Residential	1881	2003/7/23	1890	2003/7/30	9	1900	2003/8/23	1905	2003/8/30	5
31	SS XII Village T/F	525	Residential	60	2003/7/23	60	2003/7/30	0	60	2003/8/23	60	2003/8/30	0
32	SS XII Village T/F	709	Residential	285	2003/7/23	296	2003/7/30	11	320	2003/8/23	327	2003/8/30	7
33	SS XII Village T/F	728	Residential	50	2003/7/23	80	2003/7/30	30	45	2003/8/23	50	2003/8/30	5
34	SS XII Village T/F	802	Residential	378	2003/7/23	384	2003/7/30	6	384	2003/8/23	411	2003/8/30	27
35	SS XII Village T/F	217	Residential	5197	2003/7/23	5203	2003/7/30	6	5220	2003/8/23	5228	2003/8/30	8
36	SS XII Village T/F	208	Residential	111	2003/7/23	117	2003/7/30	6	140	2003/8/23	148	2003/8/30	8
37	SS XII Village T/F	733	Residential	74	2003/7/23	75	2003/7/30	1	76	2003/8/23	77	2003/8/30	1
38	SS XII Village T/F	569	Residential	768	2003/7/23	808	2003/7/30	40	810	2003/8/23	828	2003/8/30	18
39	SS XII Village T/F	714	Residential	409	2003/7/23	461	2003/7/30	52	475	2003/8/23	485	2003/8/30	10
40	SS XII Village T/F	572	Residential	114	2003/7/23	114	2003/7/30	0	275	2003/8/23	280	2003/8/30	5
41	SS XII Village T/F	398	Residential	3071	2003/7/23	3071	2003/7/30	0	3082	2003/8/23	3083	2003/8/30	1
42	SS XII Village T/F	722	Residential	48	2003/7/23	88	2003/7/30	40	105	2003/8/23	110	2003/8/30	5
43	SS XII Village T/F	343	Residential	3252	2003/7/23	3281	2003/7/30	29	3301	2003/8/23	3301	2003/8/30	0
44	SS XII Village T/F	467	Residential	1943	2003/7/23	1983	2003/7/30	40	2025	2003/8/23	2025	2003/8/30	0
45	SS XII Village T/F	427	Residential	3214	2003/7/23	3221	2003/7/30	7	3246	2003/8/23	3253	2003/8/30	7
46	SS XII Village T/F	723	Residential	215	2003/7/23	220	2003/7/30	5	235	2003/8/23	239	2003/8/30	4
47	SS XII Village T/F	804	Residential	290	2003/7/23	295	2003/7/30	5	303	2003/8/23	313	2003/8/30	10
48	SS XII Village T/F	366	Residential	754	2003/7/23	767	2003/7/30	13	812	2003/8/23	821	2003/8/30	9
49	SS XII Village T/F	647	Residential	353	2003/7/23	353	2003/7/30	0	353	2003/8/23	353	2003/8/30	0
50	SS XII Village T/F	392	Residential	4085	2003/7/23	4093	2003/7/30	8	4093	2003/8/23	4114	2003/8/30	21
51	SS XII Village T/F	282	Residential	0	2003/7/23	0	2003/7/30	0	1	2003/8/23	1	2003/8/30	0
52	SS XII Village T/F	618	Residential	1173	2003/7/23	1173	2003/7/30	0	1173	2003/8/23	1173	2003/8/30	0
53	SS XII Village T/F	708	Residential	169	2003/7/23	171	2003/7/30	2	173	2003/8/23	176	2003/8/30	3
54	SS XII Village T/F	719	Residential	871	2003/7/23	882	2003/7/30	11	925	2003/8/23	938	2003/8/30	13

Annex 5.3 Methodology of Loss Estimation

Methodology

1. Loss Calculation

(1) Loss kWh

kWh at outgoing of the feeder	$kWhf(Measuring)$
kWh at transformer	$kWhtr(Measuring)$
kWh at customer	$kWhc(Measuring)$
Total loss kWh	$kWhT = kWhf - kWhc$
Loss kWh at MV lines	$kWhh = kWhf - kWhc - kwhtr$
Loss kWh at LV lines	$kWhl = kWhf - kWhh$
Technical loss kWh at LV lines	$kWhlt(Calculation)$
Commercial loss kWh	$kWhc = kWhl - kWhlt$

(2) Technical loss

Technical loss includes the following:

- 11kV Line loss
- LV Line loss
- Service wire loss
- Transformer loss
- Meter loss

(3) Calculation method of technical loss at 11kV lines

Loss kW at each line of 11kV feeder is calculated as follows.

$$w = i^2 rL \quad (W)$$

w : power loss (W)

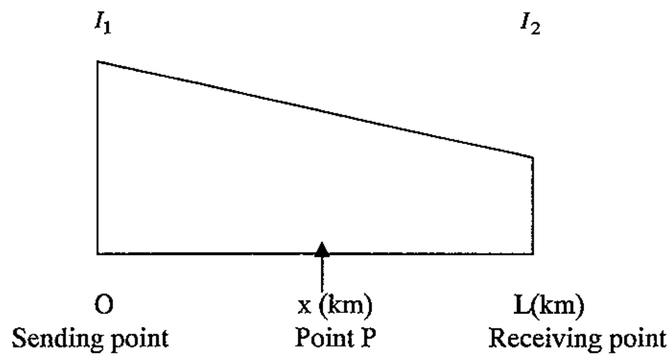
i : line current (A)

r : resistance of each line per km (Ω / km)

L : length of line (km)

I_1 : current at sending point

I_2 : current at receiving point



When load is distributed evenly between the sending point and the receiving point, the current at point P is calculated as follows.

$$Ix = \frac{(L-x)(I_1 - I_2)}{L} + I_2 = I_1 - \frac{x(I_1 - I_2)}{L}$$

Consequently, loss kW at point P is calculated as follows.

$$\Delta w = Ix^2 \cdot r \cdot \Delta x = \left\{I_1 - \frac{x(I_1 - I_2)}{L}\right\}^2 \cdot r \cdot \Delta x$$

$$w = \sum_{O}^{L} \left\{I_1 - \frac{x(I_1 - I_2)}{L}\right\}^2 \cdot r \cdot \Delta x$$

$$= \frac{r \cdot L}{3}\left(I_1^2 + I_1 \cdot I_2 + I_2^2\right) = r\left\{I_1 \cdot I_2 + \frac{(I_1 - I_2)^2}{3}\right\}L$$

Load factor (F) is calculated as follows, using maximum kW and average kW in whole year.

$$F = \frac{kWave}{kW\max}$$

Adapting the study result of Buller & Woodrow, dispersion load factor (H) is calculated as follows.

$$H = 0.3 \cdot F + 0.7 \cdot F^2$$

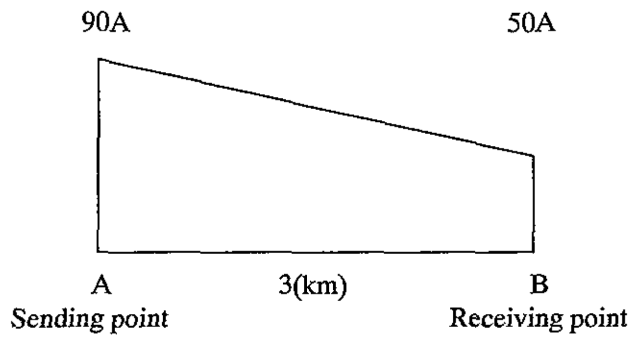
Loss kWh in whole year is calculated as follows, using maximum loss kW.

$$Loss\ kWh = I^2 \cdot R \cdot H \cdot T$$
$$= kW \cdot H \cdot 24hours \cdot 365days \quad (kWh)$$

I : Current
R : Resistance
H : Dispersion load factor
T : Time

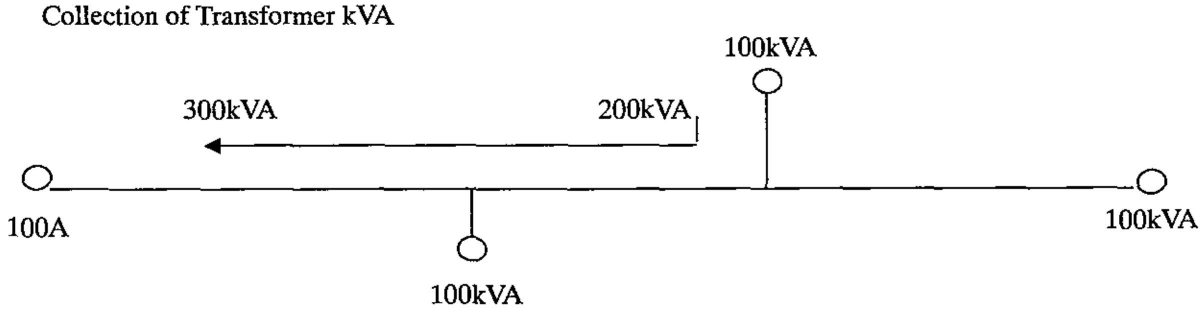
(Example)

3phase 3wires
size of wire 5mm (0.905 Ω /km)

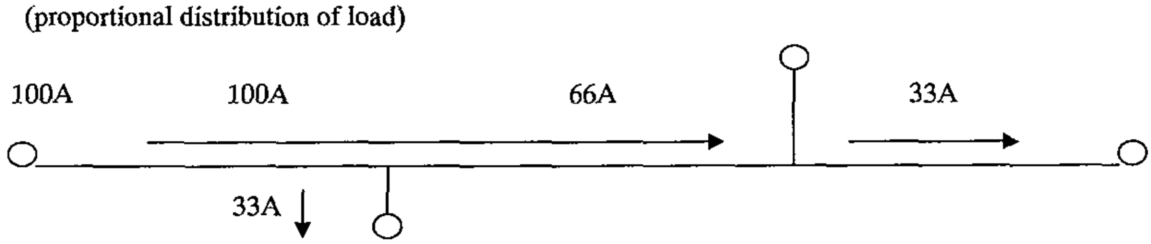


Section	calculation $3 \times r \left\{ I_1 \times I_2 + \frac{(I_1 - I_2)^2}{3} \right\} \times L$	Loss kW (kW)
$A-B$	$3 \times 0.905 \times \left\{ 90 \times 50 + \frac{(90-50)^2}{3} \right\} \times \frac{3}{1000}$	41.0 (kW)

Calculation currents at each point
-Procedure No.1
Collection of Transformer kVA



-Procedure No2.
Using maximum current at outgoing of feeder, current at each point is calculated as follows. (proportional distribution of load)



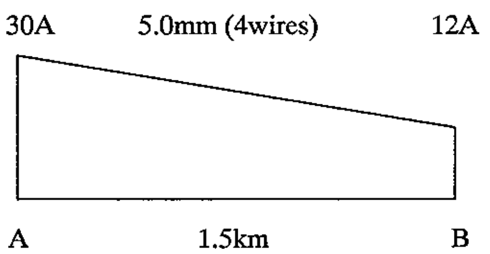
(4) Calculation method of technical loss at low voltage lines

Method is the same as 11kV line (above)

Ip = motor current
Il = lamp current
u = unbalanced rate (0.33)
CL = common line
NL = neutral line
PL = power line

	Current
CL1	$1\times\left(I_p+I_1\times\frac{1}{2}\times(1+u)\right)$
CL2	$1\times\left(I_p+I_1\times\frac{1}{2}\times(1-u)\right)$
PL	$1\times(I_p)$
NL	$1\times\left(I_1\times\frac{1}{2}\times2\times u\right)$

(Example)



Point A
Ip=10A
IL=20A

Point B
Ip=4A
IL=8A

	Current	Current A	Current B
CL1	$1\times\left(I_p+I_1\times\frac{1}{2}\times(1+u)\right)$	$10+\frac{20}{2}\times1.13=21.3$	$4+\frac{8}{2}\times1.13=8.52$
CL2	$1\times\left(I_p+I_1\times\frac{1}{2}\times(1-u)\right)$	$10+\frac{20}{2}\times0.87=18.7$	$4+\frac{8}{2}\times0.87=7.48$
PL	$1\times(I_p)$	10	4
NL	$1\times\left(I_1\times\frac{1}{2}\times2\times u\right)$	$\frac{20}{2}\times2\times0.13=2.6$	$\frac{8}{2}\times2\times0.13=1.04$

Section		Calculation	Loss kW (kW)
$A-B$	CL1	$0.905\times\left(21.3\times8.52+\frac{(21.3-8.52)^2}{3}\right)\times\frac{1.5}{1000}$	0.32
	CL2	$0.905\times\left(18.7\times7.48+\frac{(18.7-7.48)^2}{3}\right)\times\frac{1.5}{1000}$	0.247
	PL	$0.905\times\left(10\times4+\frac{(10-4)^2}{3}\right)\times\frac{1.5}{1000}$	0.071
	NL	$0.905\times\left(2.6\times1.04+\frac{(2.6-1.04)^2}{3}\right)\times\frac{1.5}{1000}$	0.005
	TOTAL		0.643

Load factor is calculated as follows.

From measured data between May and July, maximum current (Imax) and average current (Iave) at secondary side of transformer are figured out.
Using these data, power factor (F) and dispersion load factor (H) are calculated as follows.

$$F = \frac{I_{ave}}{I_{max}}$$

$$H = 0.3\times F + 0.7\times F^2$$

Loss kWh in whole year is calculated as follows.

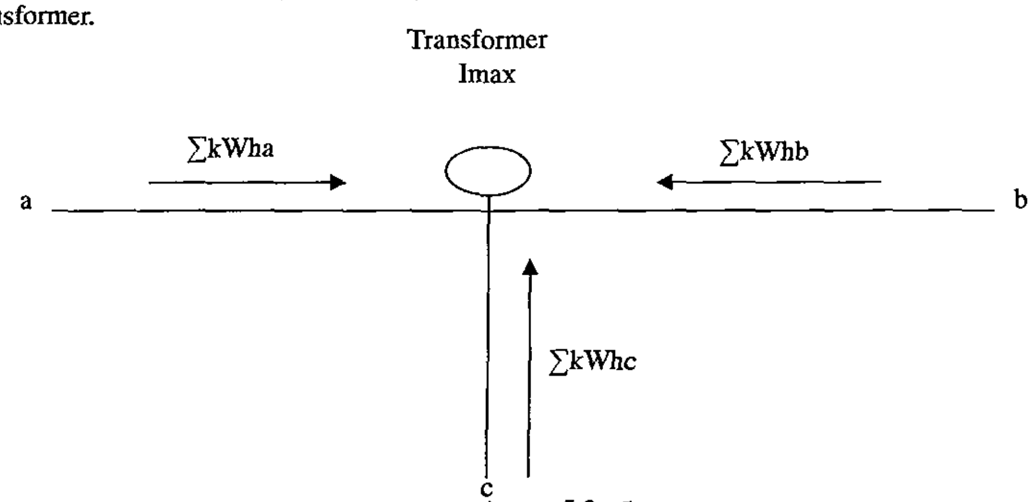
$$Loss\ kWh\ in\ whole\ year\ (kWh) = I^2\times R\times H\times T\quad (kWh)$$

I : Current
R : Resistance
H : Dispersion load factor
T : Time (24 hours * 365 days)

Calculated current at each point
-Procedure No.1

Collecting load

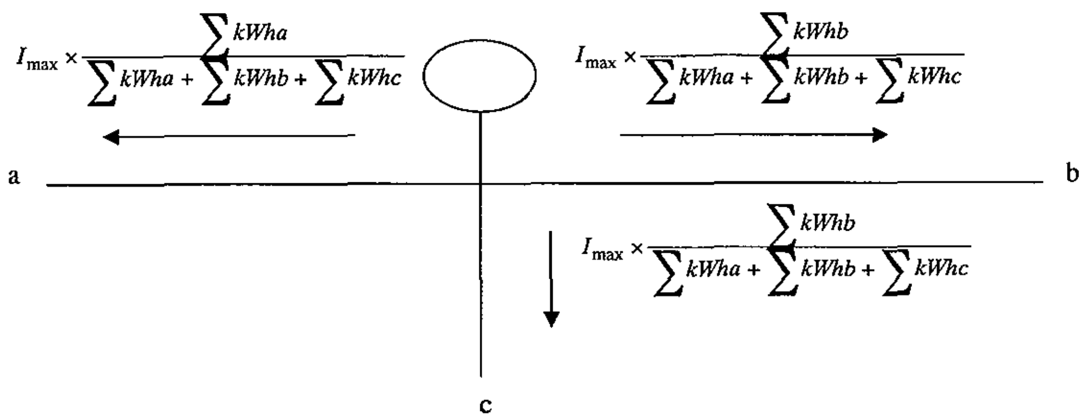
Collecting customer's kWh (peak month) from the end of LV line to the transformer's end in whole bank of transformer.



-Procedure No.2

Proportional distribution of load

Calculate maximum current of LV line of each direction as follows, using Maximum current at transformer and customer's kWh.



(5) Calculation method of other technical losses

- Transformer loss

Iron loss (Wi)

$$Loss\ kWhi = Wi \times \frac{1}{1000} \times Nos.of\ transformer \times T$$

Copper loss (Wc)

$$Loss\ kWhc = Wc \times \frac{1}{1000} \times Nos.of\ transformer \times \left(\frac{I_{max}}{I_{nominal}}\right)^2 \times H \times T$$

T : Time
H : Dispersion load factor

-Service wire loss
Same as LV line loss
-Meter

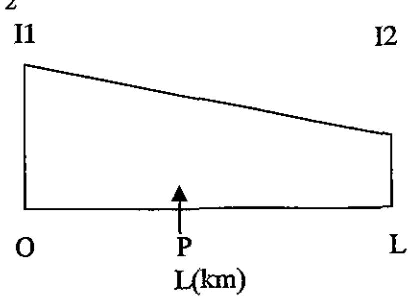
$$Loss\ kWhm = Wm \times \frac{1}{1000} \times Nos.of\ meters$$

Wm : Consumption W of meter

2. Calculated Voltage Drop

(1) Calculation method of voltage drop in 11kV line

$$Vd = \sqrt{3} \times I_{max} \times (R\cos\theta + X\sin\theta) \times L \times \beta$$
$$= \sqrt{3} \times (R\cos\theta + X\sin\theta) \times L \times \frac{(I_1 + I_2)}{2} \quad (in\ case\ of\ \beta = 0.5)$$

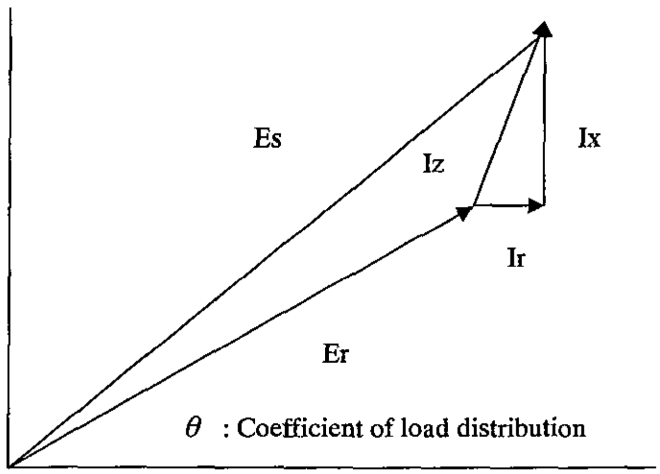


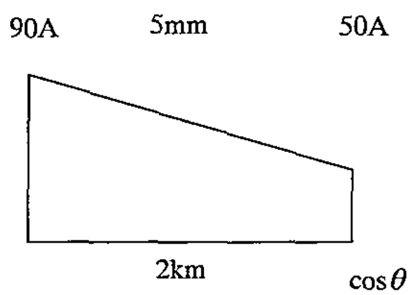
β : Coefficient of load distribution

β	distribute equally	1/2
	load distributes only at the end	1.0

$\cos\theta$: Power factor
R : Resistance Ω/km
X : Reactance Ω/km

$$Es - Er = \sqrt{3} \times I_{max} \times (R\cos\theta + X\sin\theta)$$





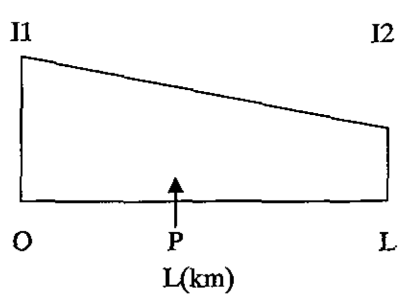
$\cos\theta$ = 0.8

section	calculation	voltage drop
A-B	$\sqrt{3} \times (0.996 \times 0.8 + 0.4592 \times 0.6) \times \frac{(90+50)}{2} \times 2km$	260.0 V

(2) Calculation method of voltage drop in low voltage line

Method is the same as 11kV line (above)

$$Vd = \sqrt{3} \times I_{max} \times (R\cos\theta + X\sin\theta) \times L \times \beta$$
$$= \sqrt{3} \times (R\cos\theta + X\sin\theta) \times L \times \frac{(I_1 + I_2)}{2} \quad (in\ case\ of\ \beta = 0.5)$$



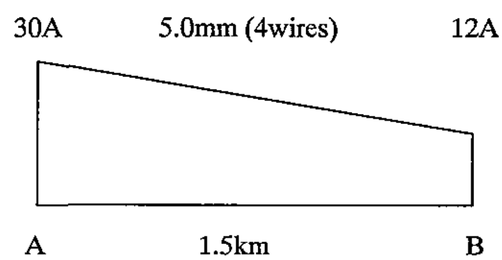
β : Coefficient of load distribution

β	distribute equally	1/2
	load distributes only at the end	1.0

$\cos\theta$: Power factor
R : Resistance Ω/km
X ; Reactance Ω/km

Phase	No. of wires	Calculation
Single	2 wires	$Vd = 2\times(R\cos\theta + X\sin\theta)\times\frac{(I_1+I_2)}{2}\times L$
Single	3 wires	$Vd = ((1+u)+2u)\times(R\cos\theta + X\sin\theta)\times\frac{(I_1+I_2)}{2}\times L$ $Vd = 1.4\times(R\cos\theta + X\sin\theta)\times\frac{(I_1+I_2)}{2}\times L \quad :u = 0.13$
3 phase	3 wires	$Vd = \sqrt{3}\times(R\cos\theta + X\sin\theta)\times\frac{(I_1+I_2)}{2}\times L$
3 phase	4 wires (Common phase)	$Vd = ((1+u)+2u)\times(R\cos\theta + X\sin\theta)\times\frac{(I_1+I_2)}{2}\times L$ $Vd = 1.4\times(R\cos\theta + X\sin\theta)\times\frac{(I_1+I_2)}{2}\times L \quad :u = 0.13$ $(I_1, I_2$ *includes motor current and lamp current*$)$

(Example)



Point A
Ip=10A
IL=20A

Point B
Ip=4A
IL=8A

	Current	Current A	Current B
CL1	$1\times\left(I_p + I_1\times\frac{1}{2}\times(1+u)\right)$	$10+\frac{20}{2}\times 1.13 = 21.3$	$4+\frac{8}{2}\times 1.13 = 8.52$

Section		Calculation	Voltage drop
A-B	CL1	$1.4\times(0.996\times 0.8 + 0.4592\times 0.6)\times\frac{(21.3+8\ 52)}{2}\times 1.5km$	33.6 V

3. Current bottlenecks of distribution facilities

(1) 11kV line (Max current at outgoing of feeder : Allowable max current)

(2) LV line (Max current at outgoing of LV line : Allowable max current)

(3) Service wire (Max current at outgoing of service wire : Allowable max current)

(4) Transformer (Max current at secondary side of transformer : Allowable max current)

(5) Meter (Max current at customer's end : Allowable max current)

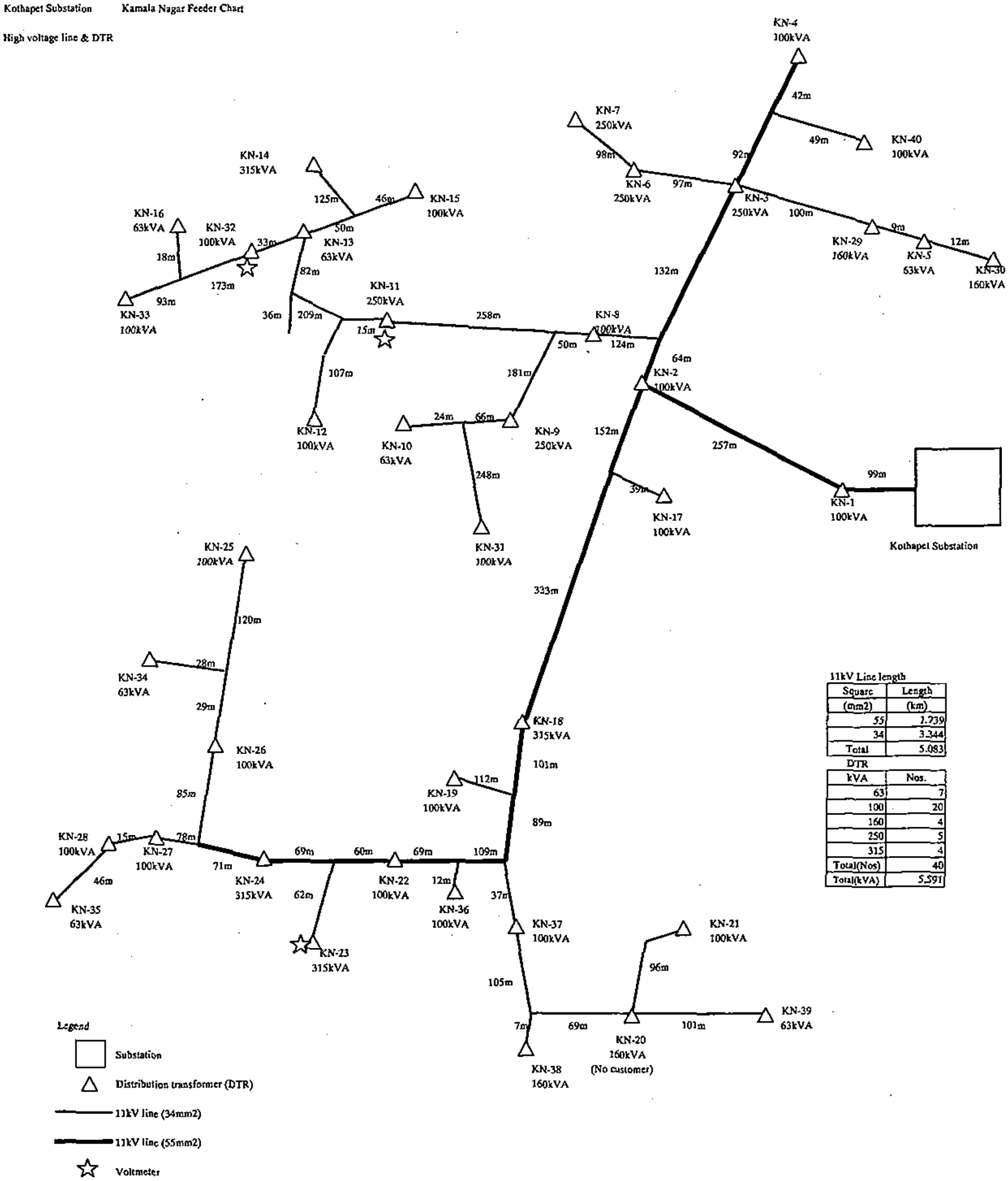
Annex 5.4 Distribution Diagrams

Annex 5.4

(3 charts of the first half are distribution diagrams of 11kV line and remaining 3 charts are distribution diagrams of Low voltage line)

Kothapet Substation Kamala Nagar Feeder Chart

High voltage line & DTR



11kV Line length

Square (mm2)	Length (km)
55	1.739
34	3.344
Total	5.083

DTR

kVA	Nos.
63	7
100	20
160	4
250	5
315	4
Total(Nos)	40
Total(kVA)	5,591

182

Annex 5.4 Distribution Diagrams

Kattedan Kattedan No..2 Feeder

High voltage line & DTR

11kV Line length

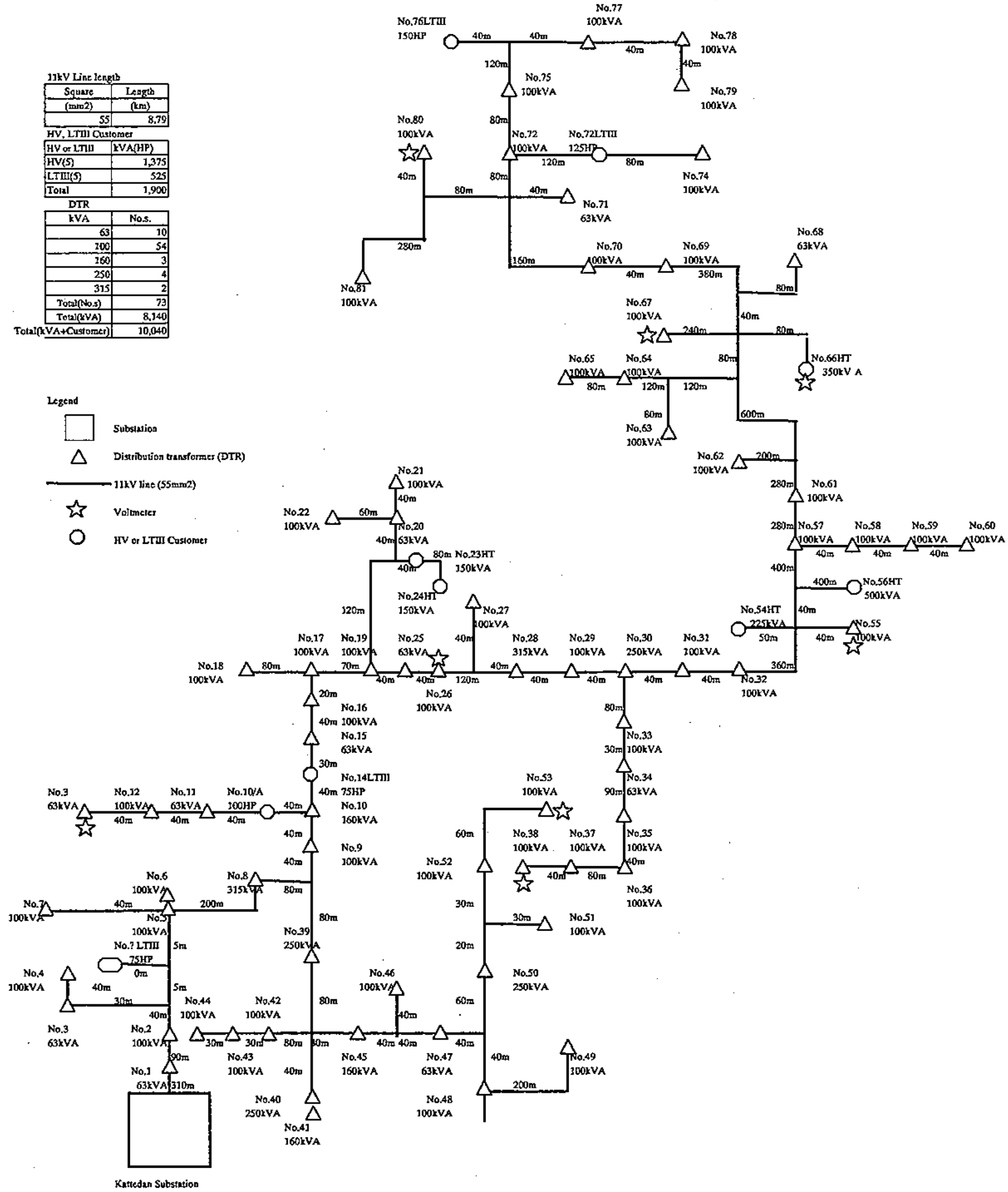
Square (mm2)	Length (km)
55	8.79

HV, LTIII Customer

HV or LTIII	kVA(HP)
HV(5)	1,375
LTIII(5)	525
Total	1,900

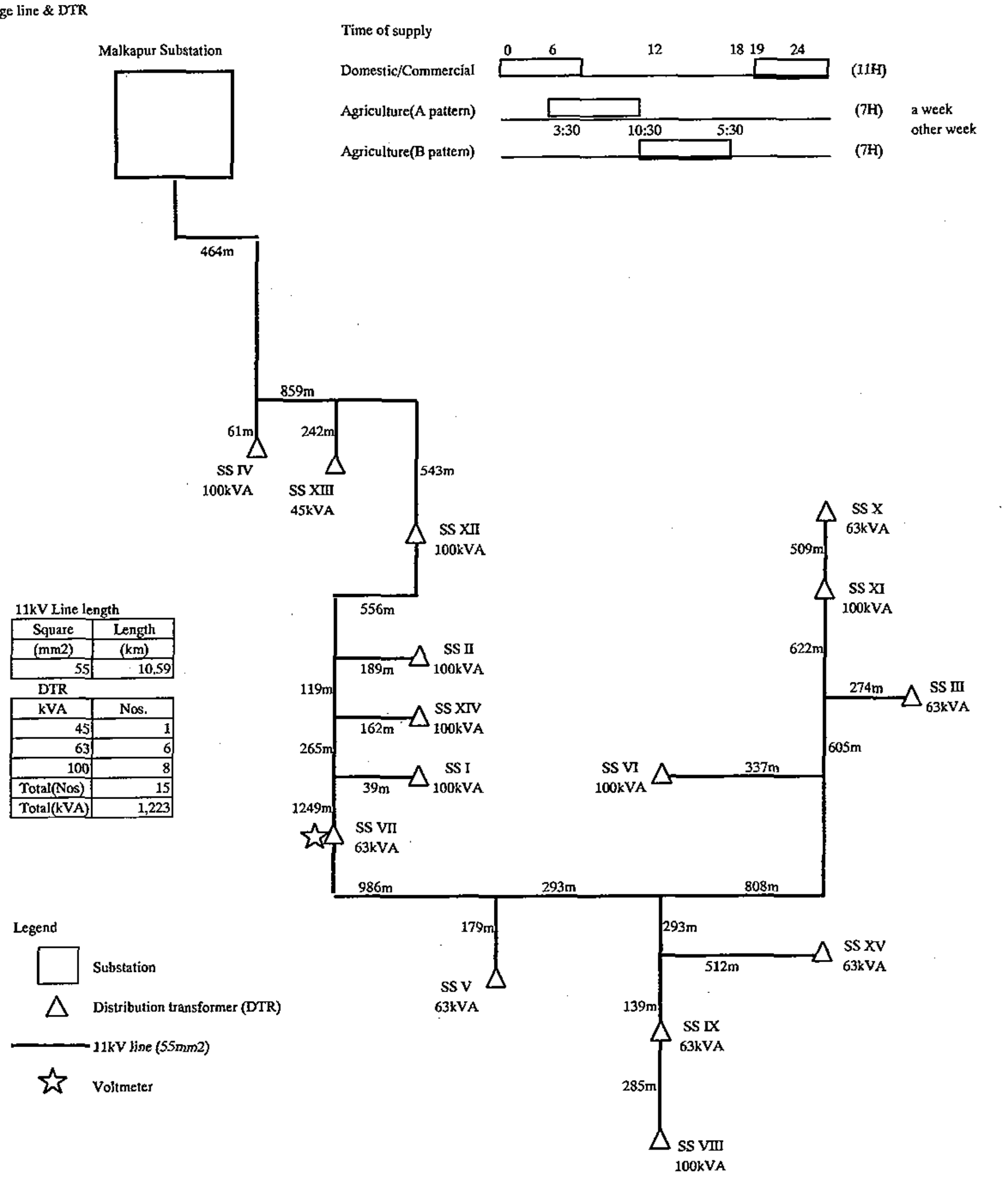
DTR

kVA	No.s.
63	10
100	54
160	3
250	4
315	2
Total(No.s)	73
Total(kVA)	8,140
Total(kVA+Customer)	10,040



Malkapur — Malkapur feeder

High voltage line & DTR



11kV Line length

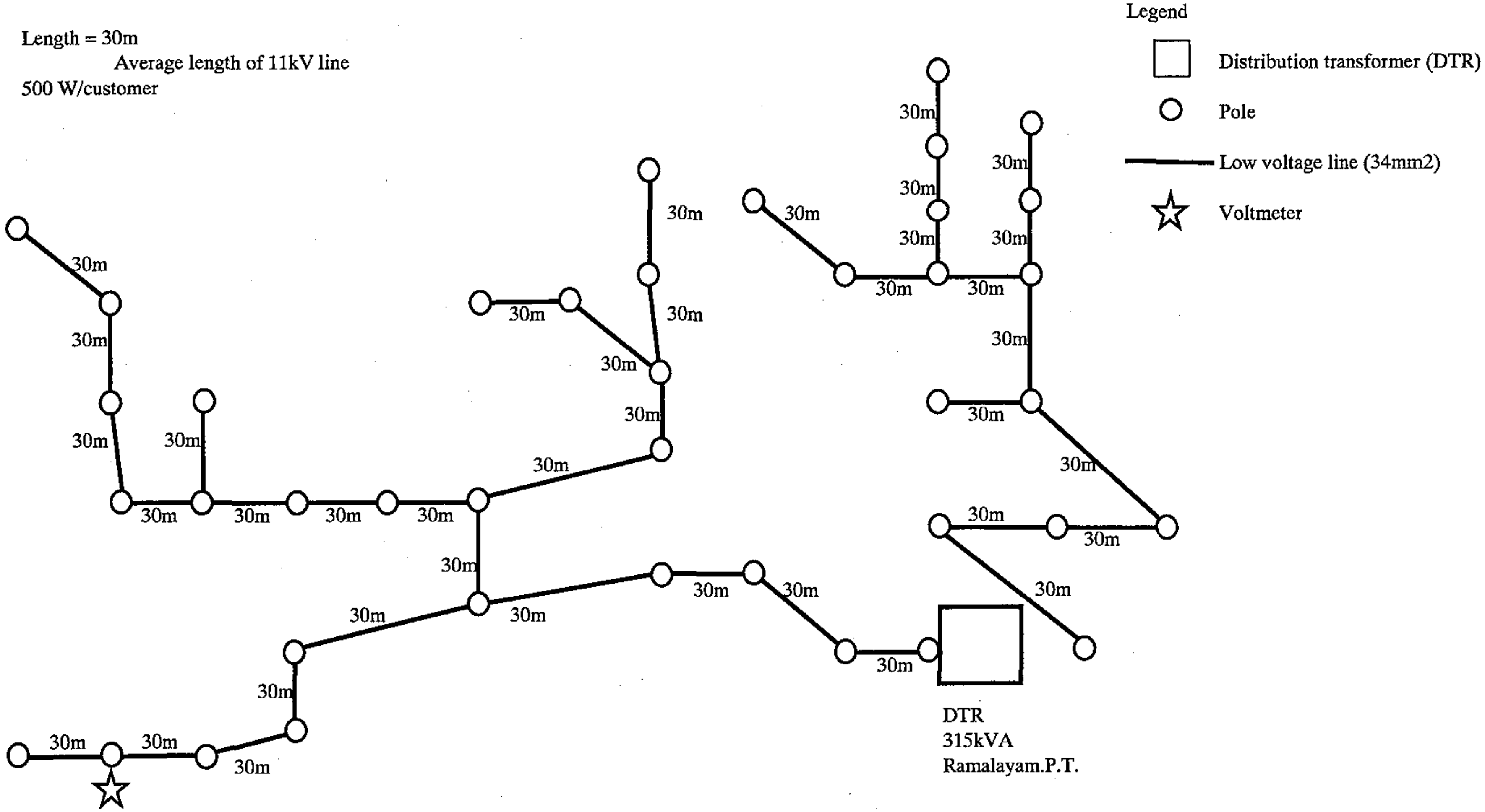
Square (mm2)	Length (km)
55	10.59

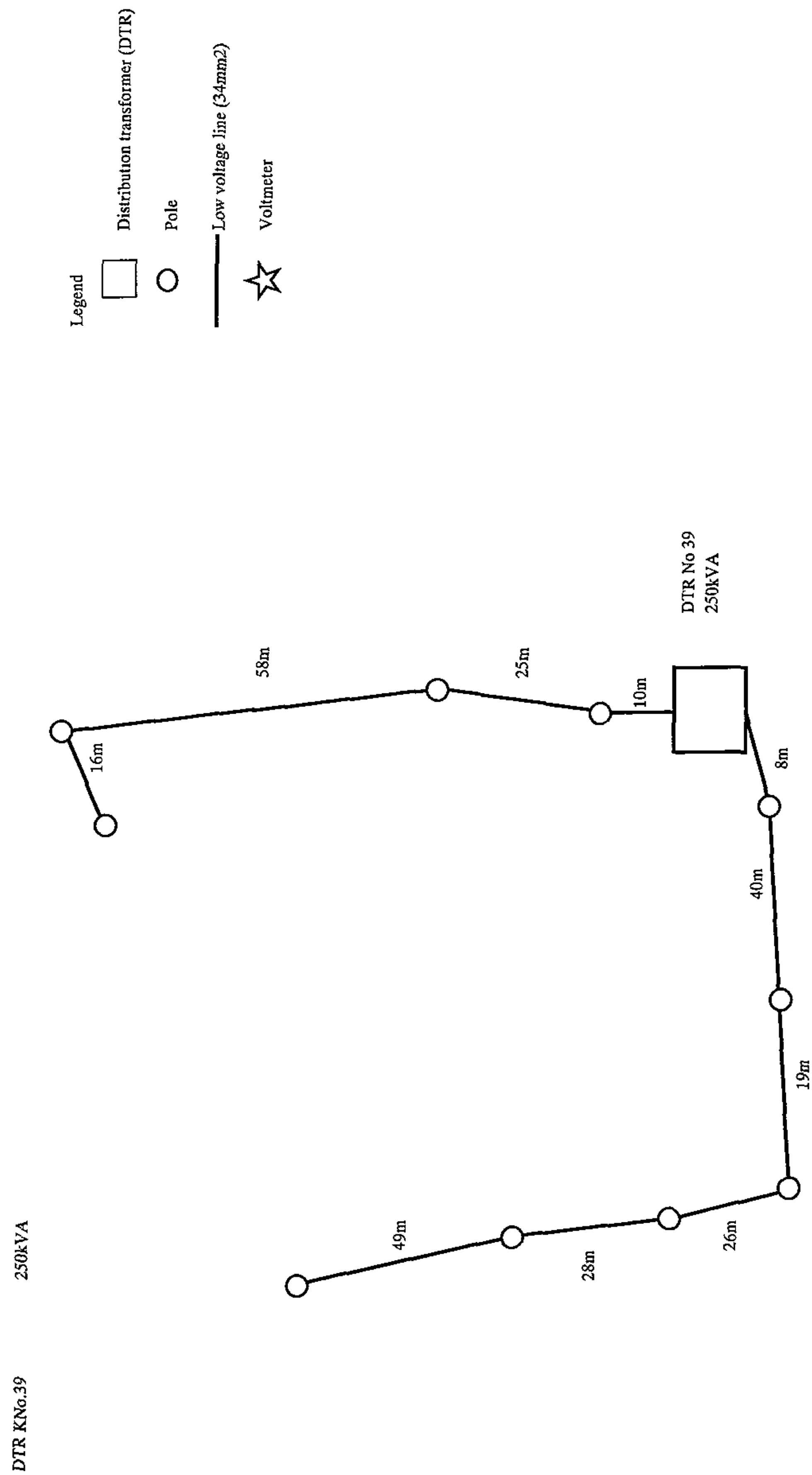
DTR

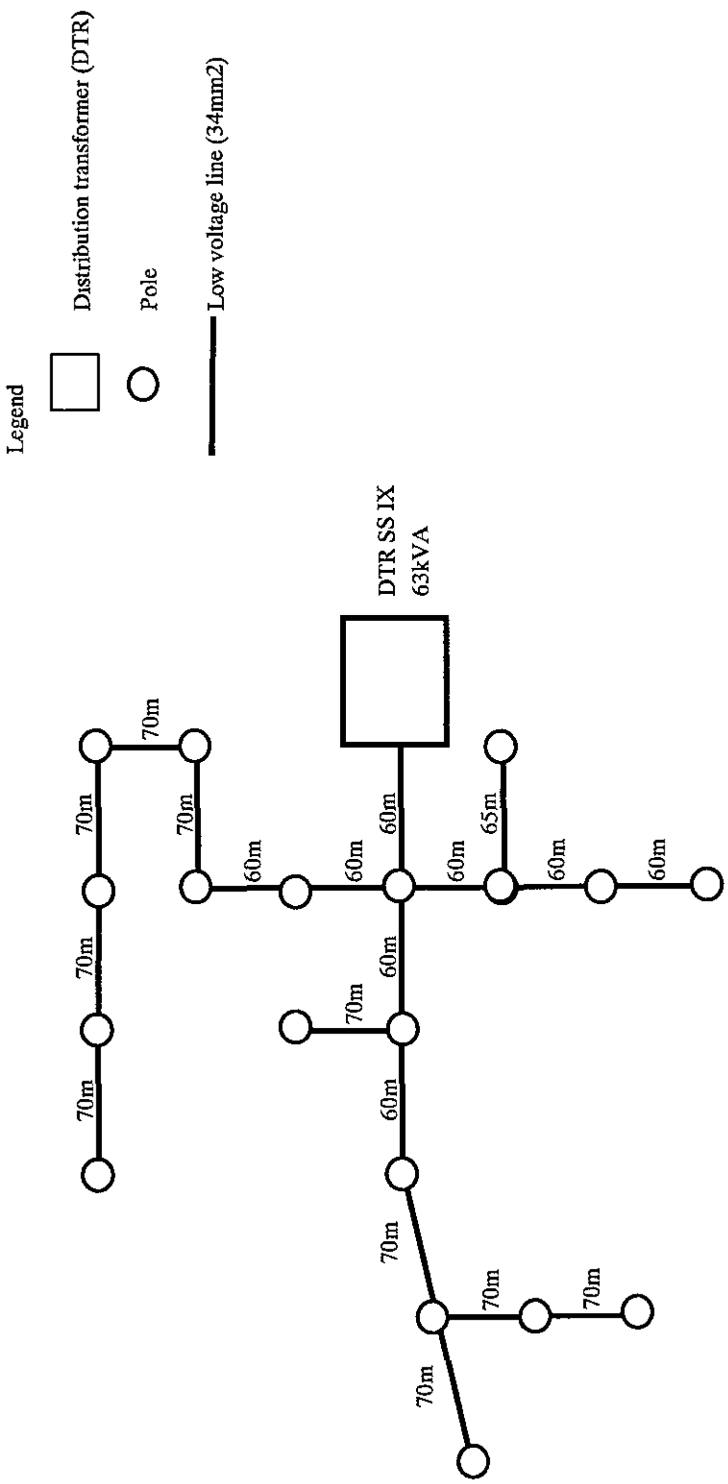
kVA	Nos.
45	1
63	6
100	8
Total(Nos)	15
Total(kVA)	1,223

DTR KN-14 315kVA Ramalayam P.T.

Length = 30m
Average length of 11kV line
500 W/customer




Legend
Distribution transformer (DTR)
Pole
Low voltage line (34mm2)
Voltmeter
DTR No 39
250kVA
58m
25m
10m
16m
8m
40m
19m
26m
28m
49m
DTR KNo.39
250kVA



DTR SS IX 63kVA

Chapter 6 Facilities and Customer Management by Use of GIS

Contents

Chapter 6 Facilities and Customer Management by Use of GIS

6.1 General

6.1.1 What is GIS?

GIS stands for "Geographic Information System". GIS systems can display and analyze various data easily in computer maps. City infrastructure data such as roads, sewage systems, gas and electricity are examples of the mapping power of GIS systems. Managers can easily display and track information for customer's facilities with this visual approach. GIS consists of a "Base Map" for basic structures, which allows for easier management and analyses of key attributes via this "layers" approach.

6.1.2 Structure of Distribution GIS

Distribution GIS enables users to draw the electric connection of the complex distribution facilities on the map. Since this system can consolidate not only positional information but also its attributions and multimedia information such as digital photos, the introducing of GIS to data management is expected to have a large impact in the electric power industry. Furthermore, it is now easy to create the power distribution system map in each region or substation.

6.1.3 Substation for GIS Mapping

Three substations were selected for introduction of GIS mapping on trial. These substations are Kothapet and Kattedan substation in Ranga Reddy district and Malkapur substation in Medak district. Main customer in the Kothapet substation is classified into domestic in the contract category. The Kattedan substation is located in an industrial area and major customer is a factory. The Malkapur substation is located in an agricultural area and supplies electricity to households and pump sets for irrigation. In this study, the study team is making three types of distribution GIS mapping such as domestic, industry, and agriculture, and the effect of GIS mapping will be examined for each type of substation.

6.1.4 Adoption to Andhra Pradesh in India

The aim of the adoption of GIS to Andhra Pradesh in India is to promote the efficiency of its management method of power distribution facilities and customer information; these are now managed by manual procedures in Andhra Pradesh, India. Additionally, analyzing facilities and customer information by using GIS will prove effective for electric reliability and customer service.

6.2 Software

Adopted software "ArcView" from ESRI has the largest worldwide market share in the GIS field and has been widely adopted in India. In considering the expansion of GIS to additional areas, the study team decided that ArcView would be the most appropriate tool for this project. As ESRI has the agent office in Hyderabad for software support, the study team benefited from the extended service support in Hyderabad. Mapworld, the company that created the Base Map in this project, are also utilizing the ArcView software. In regards to system requirements, there was no need to upgrade the hardware systems in use since the software was compatible with Microsoft Windows XP.

6.3 Base Map

Inserting the specific data into the Base Maps, it was possible to manage the facilities and customers' information visually. To have an accurate GIS, it is important to obtain a high precision geographical Base Map. Therefore, the study team delegated this vital task to mapping experts, Mapworld, who created the Base Map of three geographic areas (Kattedan: 27km^2, Kothapet: 27km^2, Malkapur: 85km^2). Since the Base Maps are made based on site survey, their longitude and latitude are extremely precise. This allowed the study team to execute its site work very efficiently. Created base map is consisted of various layers (worship, water point, stream, road, embankment, land use, building, railway, and boundary). First four letters (MMMM) express substations (Kothapet, Kattedan, or Malkapur). The fifth letter (R) expresses feature types (point, line, or polygon). Next two letters (LL) says layer types and the last letter (G) means geographic. Table 6.1 shows layer-naming convention by a local consultant. The information was categorized into facilities and customers' information.

Table 6.1 Layer naming convention

MMMM	First four letters for substation name. eg. Kopt means Kothapet Substation
R	Feature type. L: Line, R: Polygon, P: Point
LL	Layer type.
	ro: road
	bu: building
	ws: worship (temple, mosque, church, etc.)
	wp: water point (well, overhead tank, etc.)
	sr: stream
	em: embankment
	ld: land use (cultivation, grave, scrub, park, plantation, play ground, etc.)
	bo: boundary
	rw: railway
G	Geographic

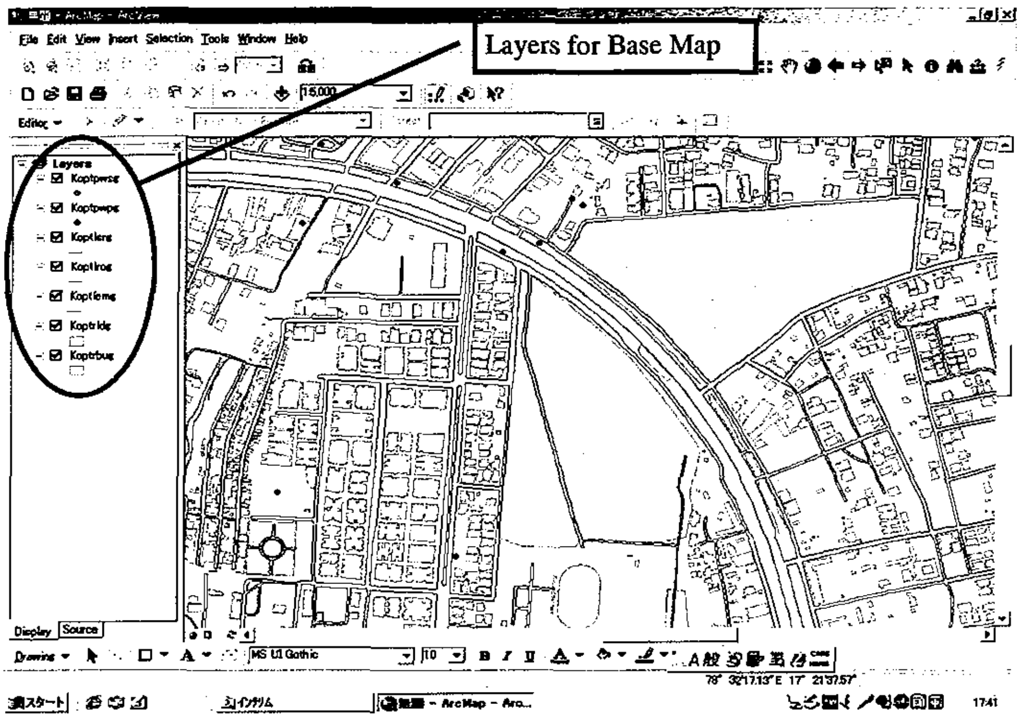


Figure 6.1 Created base map by local consultant

6.4 Facilities and Customers Information Management

6.4.1 Management of Facilities and Customers Information in Japan

(1) Present situation in Japan

Adoption of GIS system to distribution management such as facilities and customers information has begun since about 5 years ago in Japan. And now it is quite common among Japanese electric utilities to use GIS. Until then they managed data of the facilities and the customers manually by drawings on paper or database software. But GIS makes it possible to manage these kinds of data integrated with geographical map.

Because of the spread of world-wide-web and local-area-network, the information management is not restricted in its office but all thought the offices' data are accumulated in the host computer. So it is possible to manage totally all those data beyond the many branch offices.

(2) Data utilizations

- The largest effect is expected by adoption of GIS in two points as follows.
- Retrievals of data in practical use
- Update of data for management

Formerly it took much time to response inquiries from customers or to specify actual facilities, but now it takes no time to response customer's needs after adoption of GIS.

Wide revision of distribution facilities data is indispensable by repair and construction. But update of data got rather easy by total introduction of GIS and administrators in one office can get present information of the spot timely. Besides this by using the drawing function of GIS electric facilities can easily output the drawings of specifications for contractors and cut down the construction period.

Thus GIS enables users to manage information of the facilities and the customers exactly, to make progress in efficiency of data management and to improve electricity supply reliability and quality of customer services through adequate maintenance of facilities.

(3) Functions in software

Most of GIS introduced in Japan are utilized by connection with other systems as follows:

- Designing system of distribution planning
- Display system of blackout area in case of electric failure
- Calculation of transformer load, wiring load and adoption of low voltage wire size
- Display system of distribution feeders

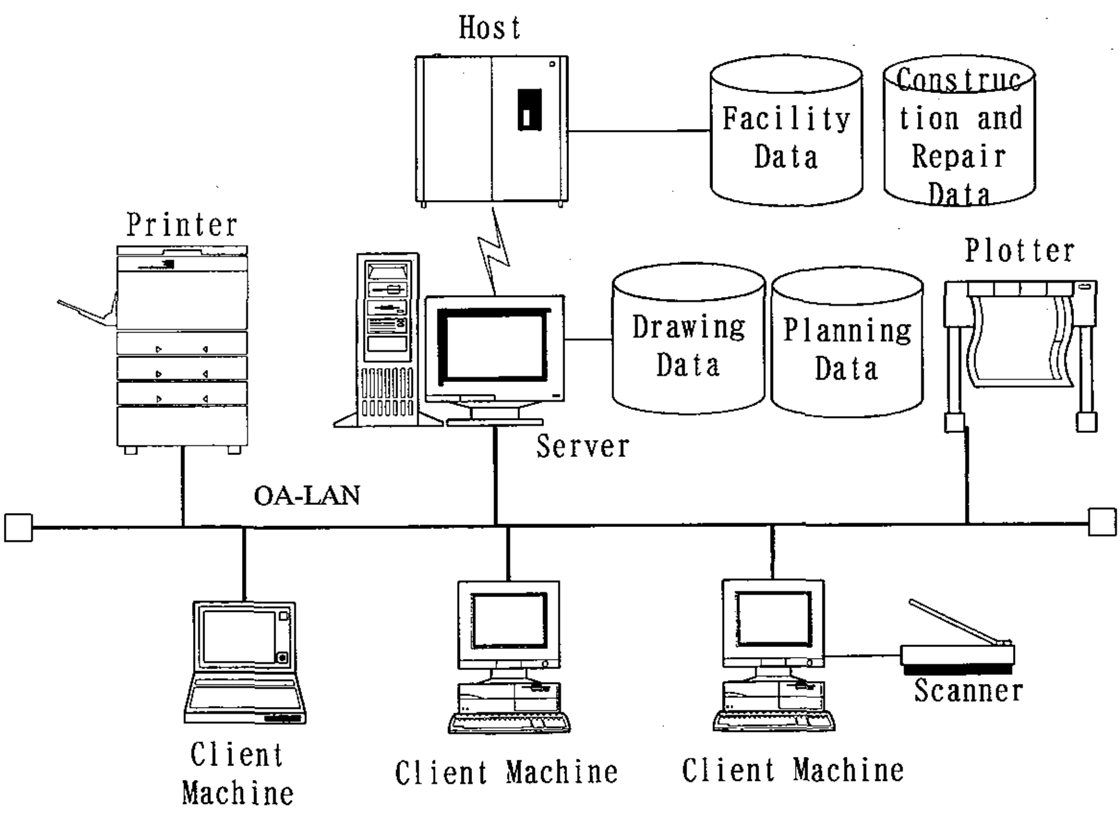


Figure 6.2 Integration of mapping system

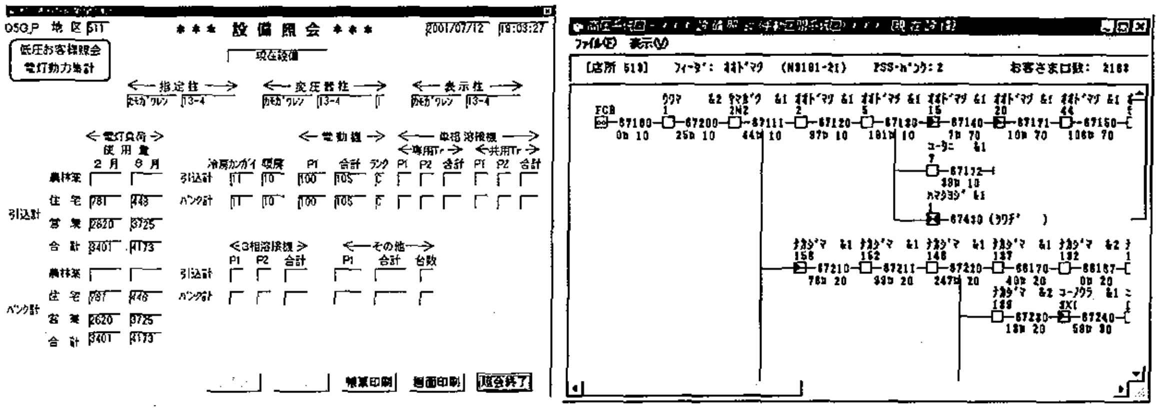


Figure 6.3 Load calculation system and feeder mapping

6.4.2 Present Situation and Needs to be Improved Issue

(1) Facilities and customers data management

The state of Andhra Pradesh in India has so many populations and so many electric distribution facilities that especially, the state capital in Hyderabad, new constructions and works of the distribution facilities are frequently because of its urbanization. Therefore, it is quite important to manage the distribution facilities respectively and adequately in order to maintain these functions.

Additionally, the development of industries such as IT requires the electric supply reliability and the customer services. The management of the basic data such as facilities and customers is indispensable in order to achieve the adequate maintenance of the facilities, the collection of the proper electricity fee and also the installations of the new technologies such as electric distribution automation.

The information of the distribution facilities and the customers in India is very simple compared to that in Japan, and there are not many items to be managed. The study team held meetings with counterparts at the site and decided minimum amounts of information with the GIS prototype of this project.

(2) The present situation of the management

In the state of Andhra Pradesh, managers are not used to applying either geographical maps or house maps, and they need much time to specify their locations on maps. They are now making distribution system map by hand. They have to understand the advantage of GIS than their manual procedures.

The study team noticed the fact that the most of the electric distribution facilities have no specific number or name, so the study team proposed numbering the facilities. Then, they agreed to number the pole transformers but they hesitated to number the electric poles because of its cumbersome.

Here are the present situation, issues of the management for the facilities and the customer data and GIS prototype that the study team created at this site survey.

6.4.3 Distribution Facilities Information

The current situation of distribution facilities information management suffers from variances from office to office. In general, printed-paper-based management is utilized for distribution transformers and low tension poles since field-staff visit them when reading the meter for electricity fees. There is no unified management procedure at 11kV high tension poles and lines -- experienced line-staff at each substation manage high tension data without the use of information systems. However, handling each facilities and customer data in a unified manner is indispensable to control the expected rise of in coming data. This rise in data is attributed to additional housing and apartments that are being developed in new residential areas. This demand to keep pace with this ever-expanding need for electricity is creating a greater need for new power distribution. This situation is ideal for the introduction of GIS and the many advantageous it offers over past systems. During the third site survey, the study team concentrated efforts in providing our counterparts the GIS images as well as conveying their importance to the operation. The study team obtained the location data of each facility and also created GIS in consideration of site operation circumstances. The power distribution facilities data was entered into GIS with the following data;

Table 6.2 Facilities data

33/11kV Substation		name, capacity, feeder name
11kV line	Pole	pole No., material
	High voltage Line	length, conductor size and material
	Auto Breaking Switch	pole No., breaking capacity
Pole-mounted transformer		pole No., capacity
430V line	Pole	pole No., material
	Low voltage Line	length, conductor size and material

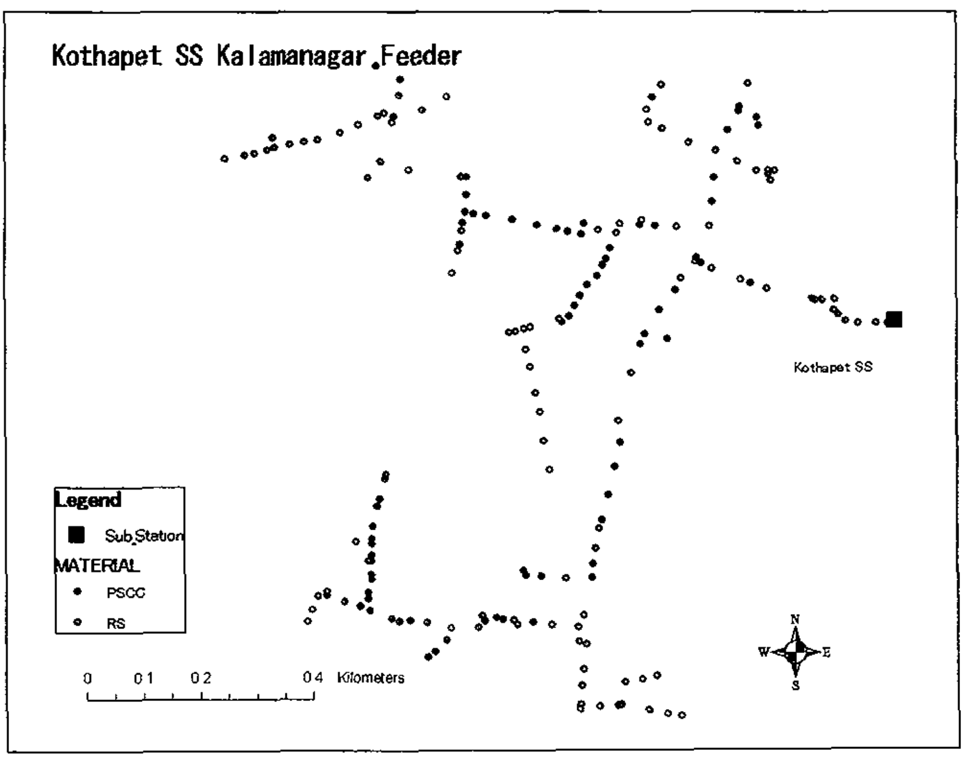


Figure 6.4 11kV pole layer of Kothapet substation

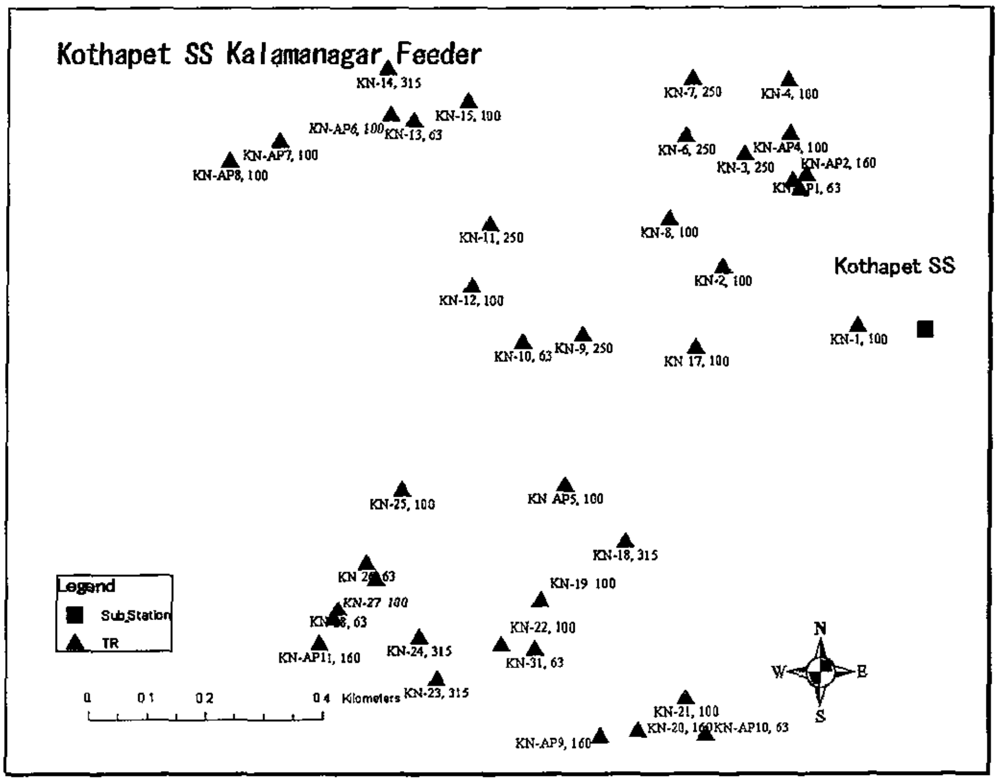


Figure 6.5 Transformer layer of Kothapet substation

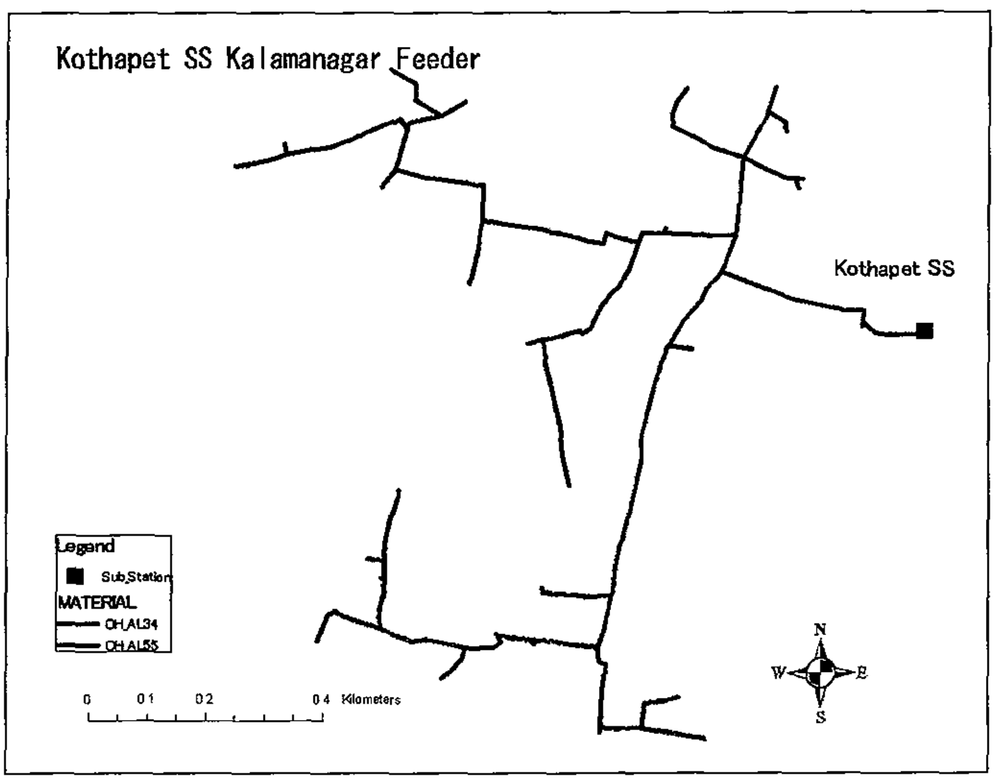


Figure 6.6 11kV HT line layer of Kothapet substation

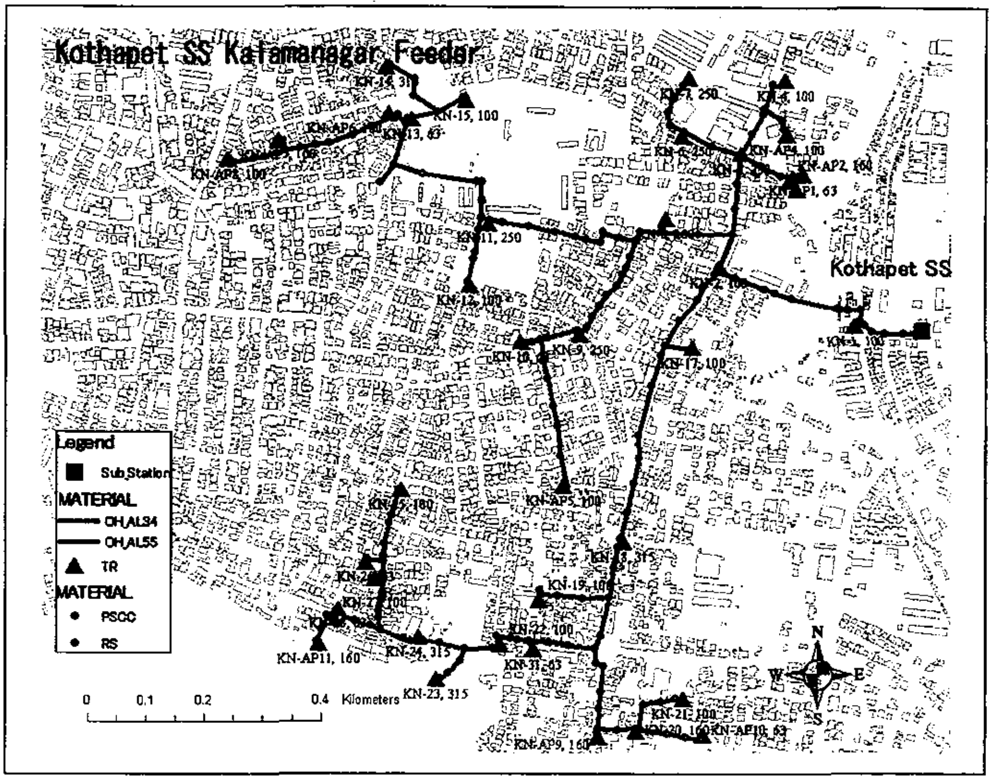


Figure 6.7 Overlap layer of Kothapet substation

6.4.4 Customer Information

Customer information is currently managed by: customer ID, personal data such as name, address, category, and meter data. However in operation, this data is not related with local distribution facilities data. Therefore, it is difficult to determine which transformer and pole supplies electricity to each customer. GIS has a customer layer linked by geographical facilities data on the map. This enables managers to view the data relationships between the customer and the local distribution facilities on the same map.

Table 6.3 Customer data

Domestic	customer No., name, address, tariff category, meter data
Industry	Ditto
Commercial	Ditto
Agriculture	customer No., name, address, meter data, pump capacity

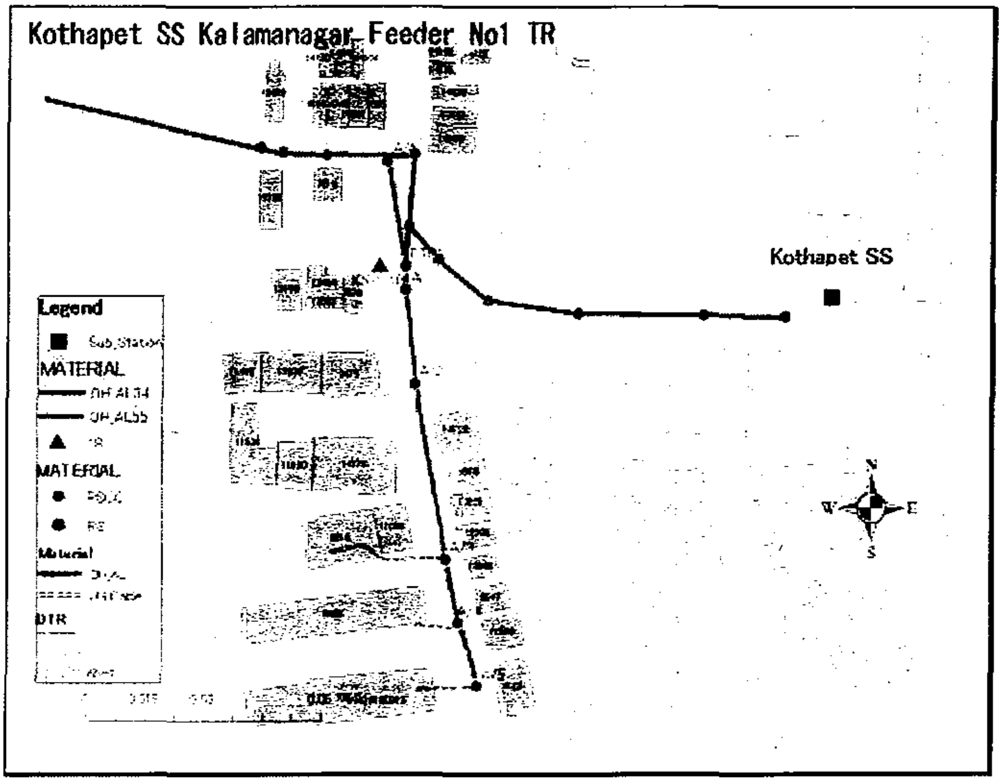


Figure 6.8 LT line and customer layer of Kothapet substation

6.5 Main Function of ArcView

There are many useful functions for the customer and facility management in ArcView. The followings are typical functions for the distribution GIS mapping.

(1) Attribute table of layer

The layer expressed by ArcView contains a lot of information. This information can be found out by opening the attribute table. Moreover, it is possible to add necessary items, to modify data, to sort record, to find record with particular attribute value, and so on in the attribute table. Attribute table is very useful for facility and customer management as database.

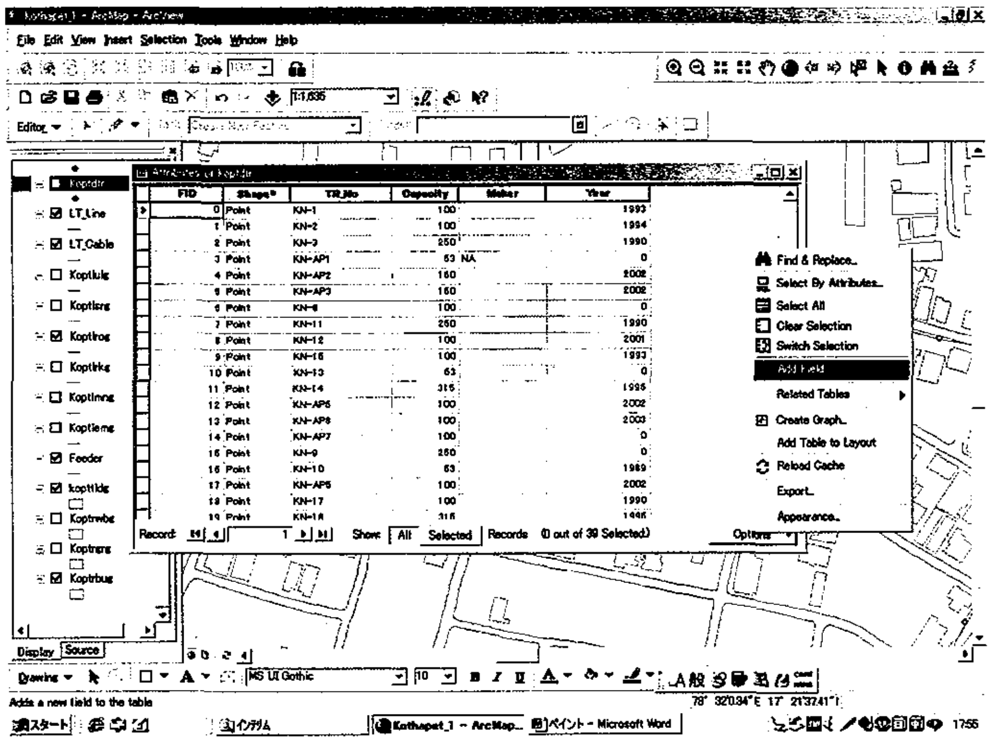


Figure 6.9 Attribute table for layer

(2) Information on feature

To confirm information on an individual feature, the attribute table need not necessarily be opened. Information on the feature is displayed by clicking the feature. For example, when you want to know information about the customer on the GIS map, you click its feature and find information.

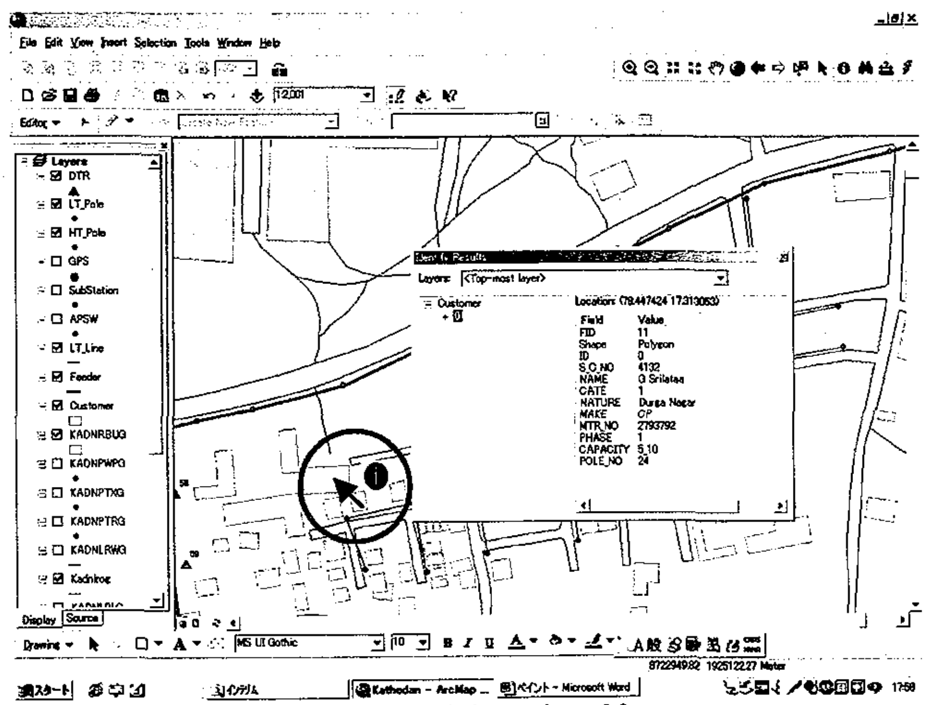


Figure 6.10 Attribute information of feature

(3) Classification of feature

There are two types of pole, concrete and steel. Also there are some types of transformer such as 100kVA, 63kVA, etc. In ArcView, the color of feature can be changed by the material of pole and the capacity of transformer. Using this function, you can identify the material of pole and the capacity of transformer without opening the attribute table.

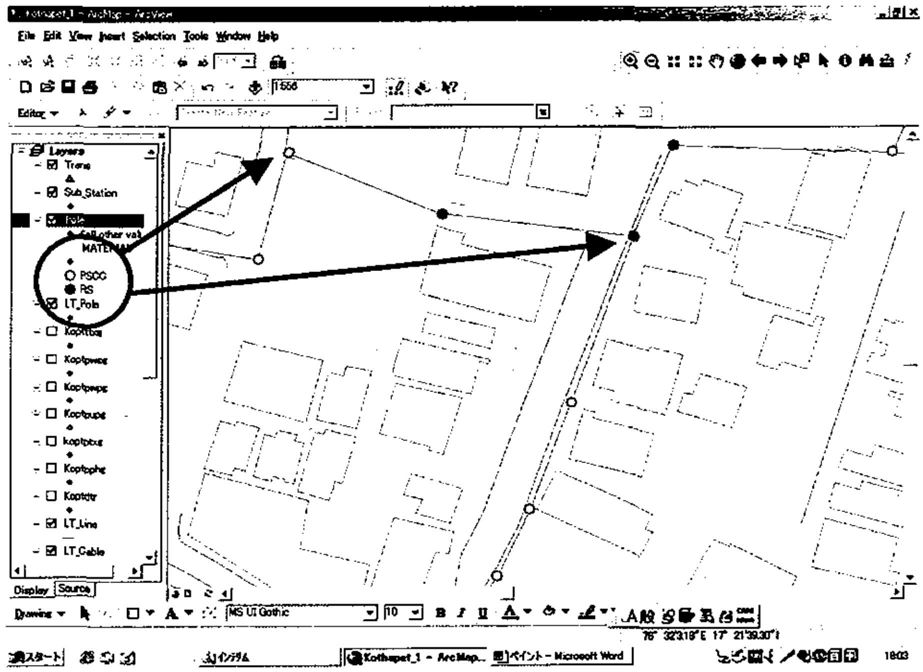


Figure 6.11 Displaying features by category

(4) Labeling

ArcView can express the data on the map such as customer's name, service number, pole number, capacity of transformer, etc.

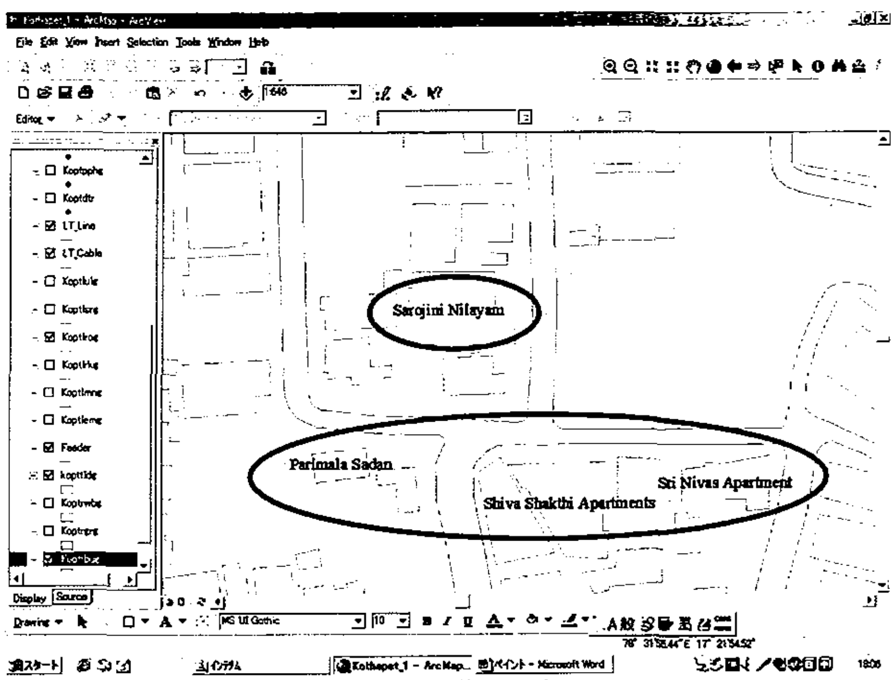


Figure 6.12 Labeling of features

(5) Measuring distance

ArcView has the measuring function for distance. You can measure the distance from substation to customer, the distance between poles, the length of 11kV feeders and so on by use of this function. Using this function, you can design an expansion plan for distribution line without going to the site survey.

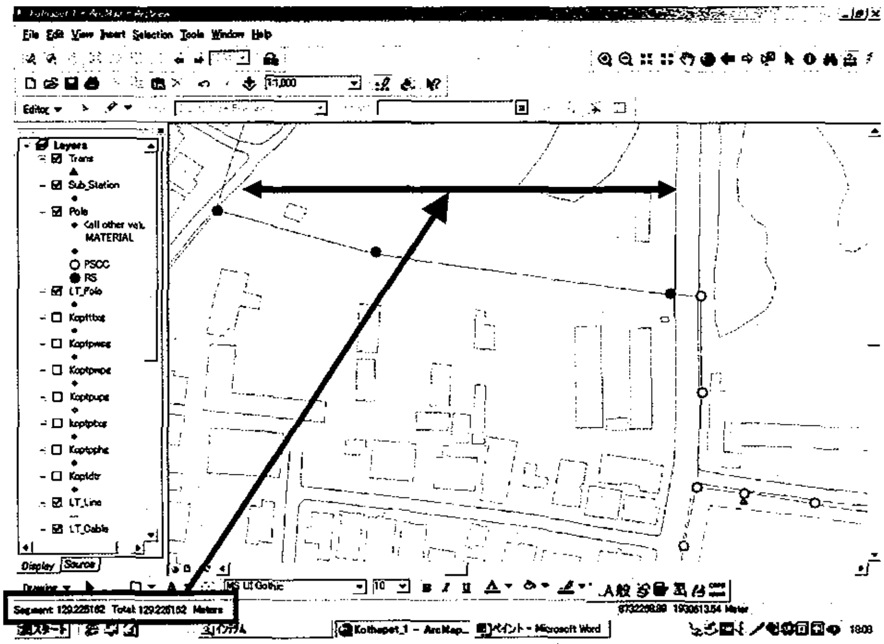


Figure 6.13 Measuring function

(6) Retrieval

ArcView can retrieve the position in according with customer's service number, name, facility number, etc. Recently the call center is set up in India for the complaint processing of the customer. The customer position is easily searched out from the customer name or the service number by using retrieval function and a prompt correspondence is possible.

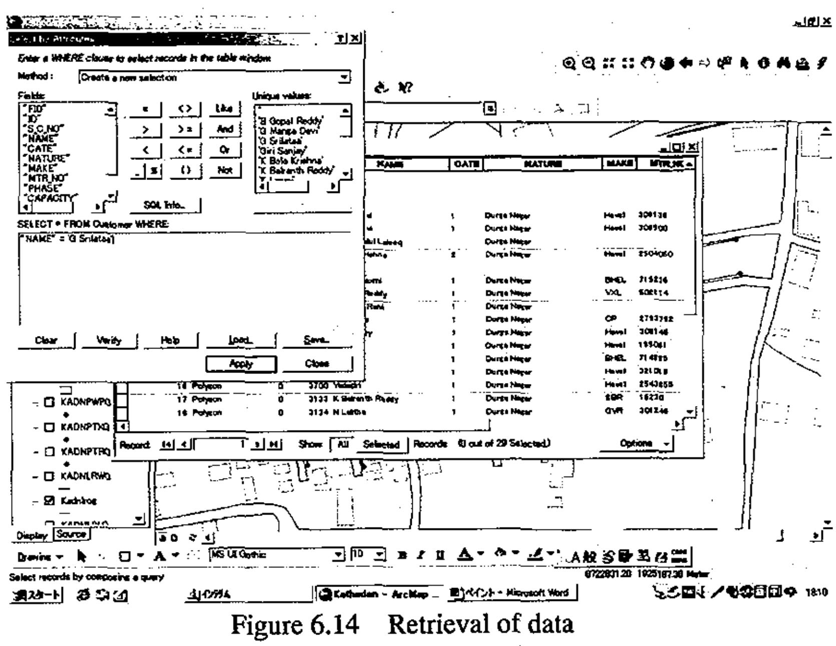


Figure 6.14 Retrieval of data

(7) Hyperlink

ArcView has the hyperlink function. You can display the photograph and the file using this function. For example, you can check the installation situation of transformer in your office without going to the site by linking the photograph in ArcView.

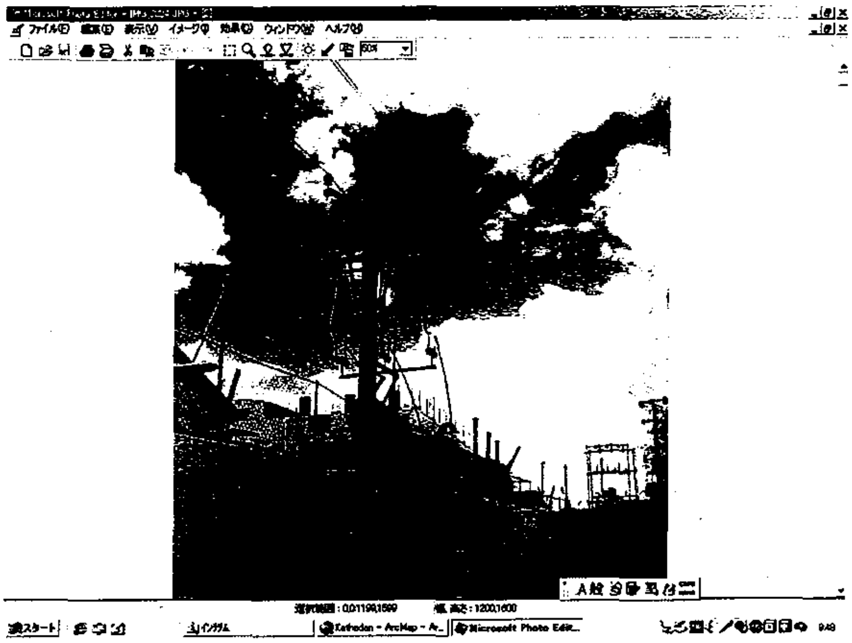


Figure 6.15 Hyperlink

(8) Graph display

Information in the attribute table can be displayed in the graph. This function is useful for the analysis of the interruption frequency of each transformer in the graph.

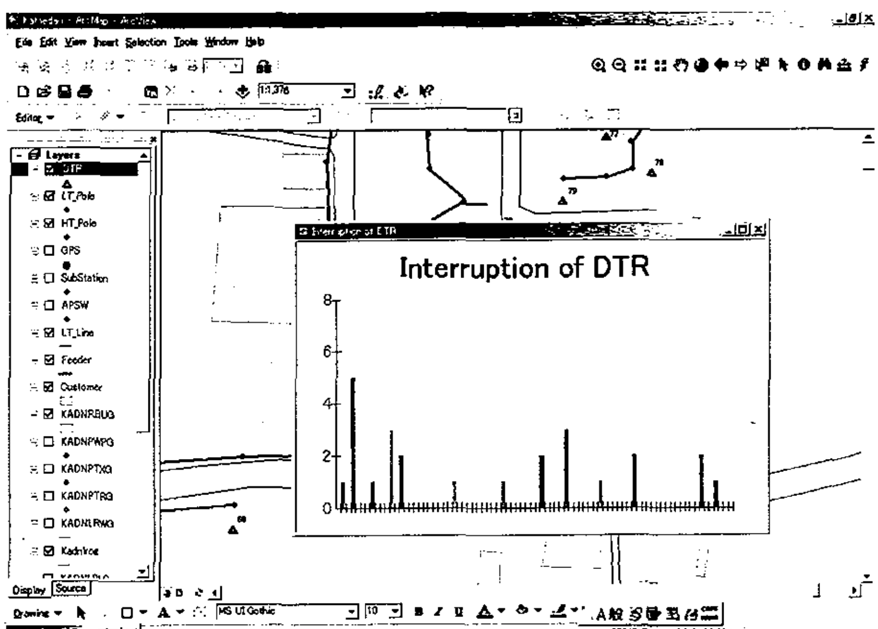


Figure 6.16 Graph display

(9) Addition of feature by latitude and longitude

When the position cannot be specified on the map, the position can be displayed by adding the latitude and longitude data to ArcView that is measured by GPS (Global Positioning System). It is effective to display the position of utility facility located in paddy field where the landmark is few.

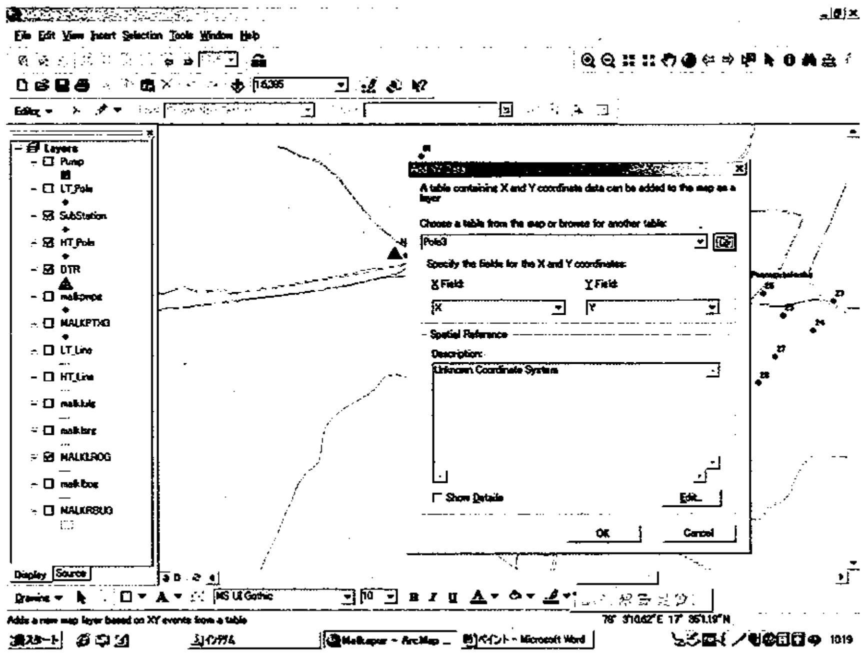


Figure 6.17 Addition of feature by latitude and longitude

6.6 Technology Transfer

The study team focused on three feeders such as Domestic, Industrial and Agricultural, and then proceeded to transfer the technology know-how of GIS creation to each counterpart. For example, the procedures necessary to collect the data, as well as entering the data to the system. Based on this training, our counterparts independently prepared the creation of the GIS system for other feeders.

Figure 6.18 shows the flow of creation for prototype GIS.

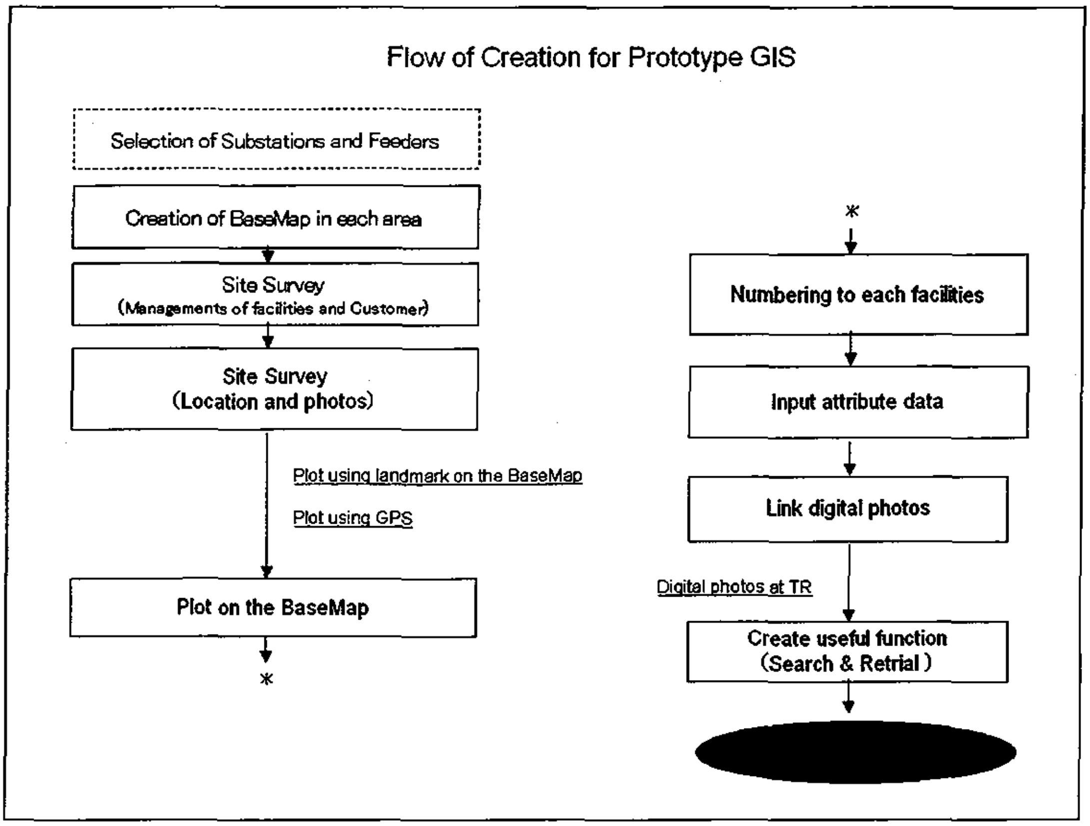


Figure 6.18 Flow of creation for prototype GIS

Distribution GIS consists of several layers as shown in Figure 6.19. The study team is using the geographic layers created by local consultant as base layer. Facility and customer layers are created by the study team and Indian counterparts, and necessary information are input in attribute table. Facility layer is divided into transformer, HT pole, HT line, LT pole, and LT line.

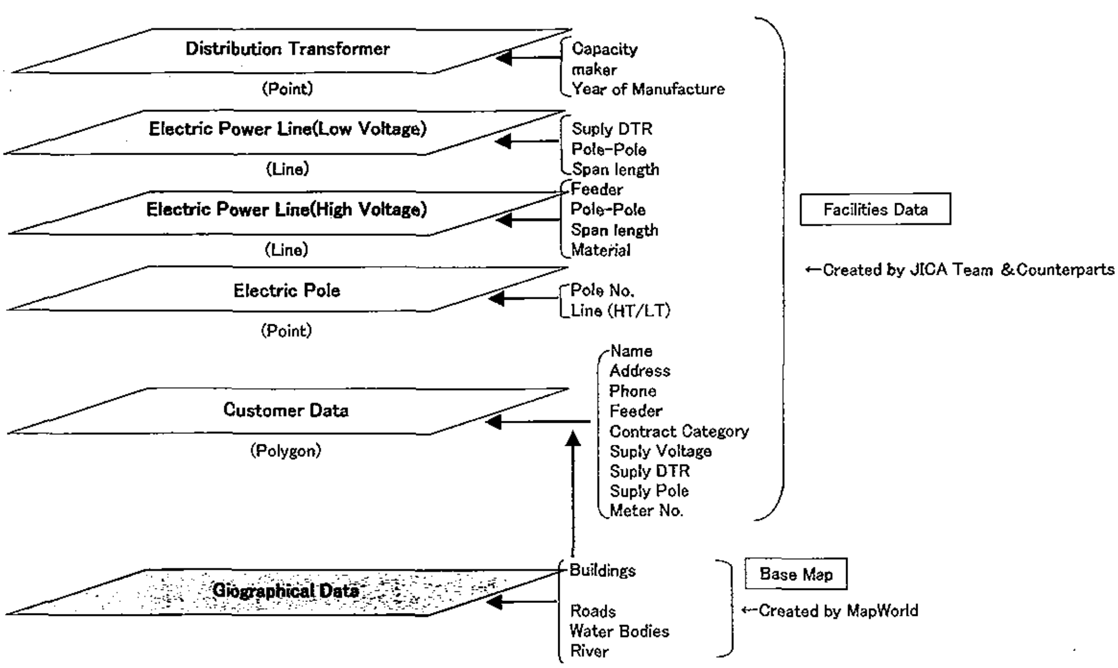


Figure 6.19 Image of structure of GIS

6.6.1 Data Collection

The study team collected necessary data for the distribution GIS mapping with our counterparts. Data for the distribution GIS mapping are classified into two categories. One is the data for the facilities' and customers' position. The other is the data for a specification of the facilities and the contents of the contract for the customers. Data collection for the position was conducted by two ways. In case of the urban area such as Kothapet and Kattedan substation that has many landmark (road, building, park, river, etc.), the study team printed the base map on a scale of 1 : 2,000 - 3,000 and carried the map for the site survey. Then, the study team filled in the positions for the facilities and the customers directly on the map. After that, the study team input data to the ArcView in the office.

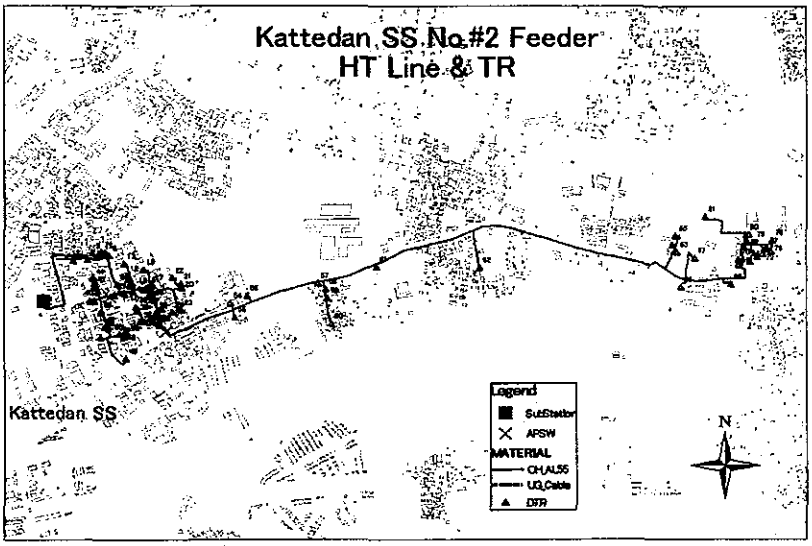


Figure 6.20 Layer of HT line in Kattedan substation

On the other hand, the study team measured every latitude and longitude for facilities and customers by using GPS in agriculture area because of no landmark. These data were input to ArcView in the office. The accuracy of the GPS is within 15m. The distance between poles in agriculture area is about 80m. Therefore, this accuracy is enough for agriculture area.

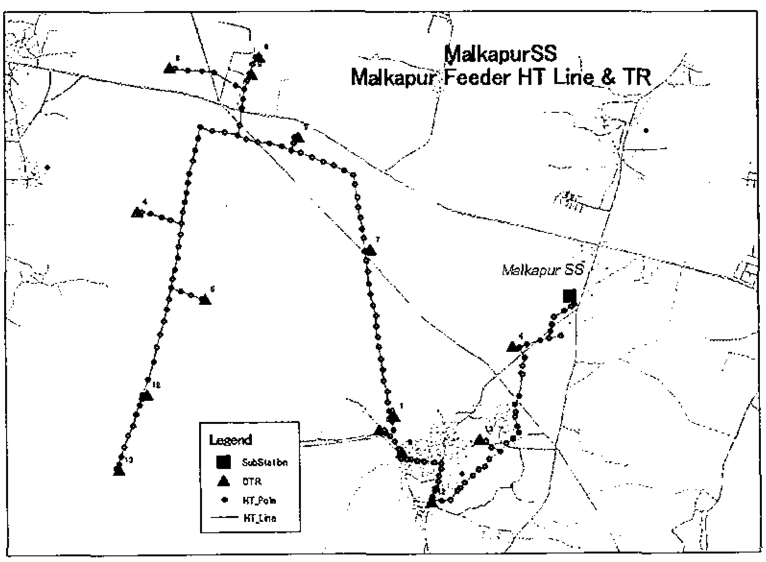


Figure 6.21 Layer of HT line in Malkapur substation

As for the specification of the facilities, the study team collected data from the facility book. However, it was necessary to check some locations of transformer because new transformers do not have an identification number.

As for the information of customers, the study team got data from MRB (Meter Reading Book). The MRB records customer name, service number, meter number, and contract category. The management of customer is better than facilities' one.

Positioning survey was carried out by the study team and local technicians together. On the other hand, the study team got information of facilities and customers from local engineers.

6.6.2 Creation of Distribution GIS

The creation of distribution GIS is conducted by local technician or engineer who is always using the personal computer in their office. The study team is guiding the way to create distribution GIS to a nominated staff. The basic operation was able to master in several days. Also, the study team transferred useful functions of ArcView by using manual.

6.6.3 Procurement of Equipments for GIS

The study team procured necessary equipments for distribution GIS and installed them at APTRANSCO, APCPDCL, and three section offices that are managing three substations.

Table 6.4 Lists of equipments

Description	Qty	Specification
Computer	6	Pentium 4, CPU 2.4GHz 256MB RAM, 40GB HDD, 15 inch Monitor
Printer	3	A3-size, Color, Inkjet
Software	6	Microsoft Windows XP Professional
Software	6	Microsoft Office XP Professional
Software	6	ESRI ArcView Version 8.3
Digital camera	3	2.0 Megapixels, 3.0 Optical zoom
GPS	6	Accuracy 15m

6.7 Utilization of GIS Data and Benefit

Since GIS can display information on the map visually, it allows even new employees to easily recognize the company's facilities and view their general descriptions for the distribution system. Furthermore, through the back-end database, staff will have access to accurate data as well as obtain the ability to perform searches and analyze the various system data variables. GIS can also perform a vital improvement in efficient customer service in terms being able to quickly access customer data, and for dispatching field staff to handle such situations as black out.

The example of effects is as follows;

6.7.1 Result of Utilizing Prototype

Utilizing the three prototypes that were created during this visit, the study team expects the following results;

(1) Site work efficiency

- Maintaining a paper-based system hinders the ability to access data that reflects the real-world data. However, a GIS system provides strong benefits in terms of enabling ease of change and modification to data related to facilities and customers.
- When the distribution facilities should be replaced, it is necessary to confirm the local situation and to prepare an appropriate materials and devices. Using GIS system, site facilities specs are available in the office.
- During the operation for electric fuse and switchgear, it is helpful to have the No. of facilities in the site. Using GIS system, it enables to check the No. and location in the office to prevent from miss operation.

(2) Recognize facilities and customer location

- Improvements and accuracy in the planning of the electric system can be realized by storing the location of electric load and facilities' data on the map.
- It is possible to forecast future demands by analyzing the consumption data for each area.
- During shut-down, managers are able to focus service staff on the specific facility due to the GIS capability to correlate transformer to the customer's location.

(3) Assistance for electricity loss management and SCADA System

- Interface to electricity loss management and SCADA System

(4) Function for customer service

- Retrieval function allows for prompt and efficient customer service

(5) Asset management

- Practical use of Hyperlink function, reference of facilities by digital photos in the office

(6) Office efficiency

- Digitalization enables to reduce paper base storage and save paper resources

6.7.2 Potential for Adopting Full Scale System

(1) Site Work Efficiency

- GIS provides the big benefit for cutting trees and safety distance observation from construction buildings. Manager can streamline their site inspection to manage the information about cutting trees and construction buildings.

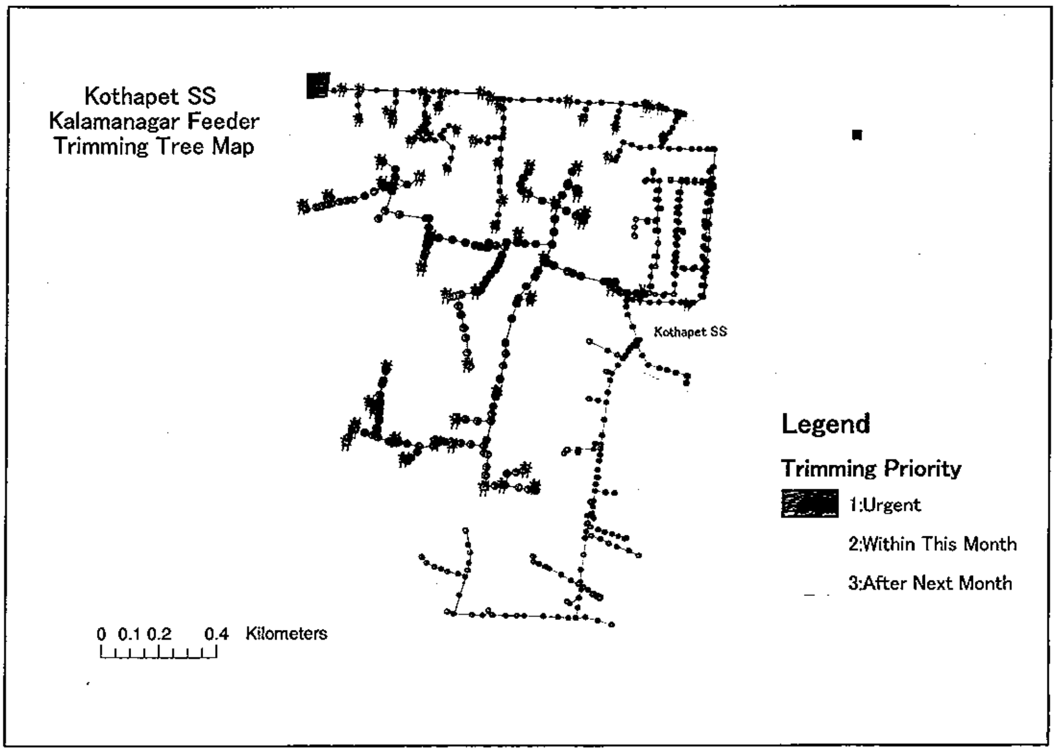


Figure 6.22 Example of trimming tree map

(2) History Data Management

- GIS can store and show the history data on the map. To manage these cautionary notices, it is useful to prevent from past failures.

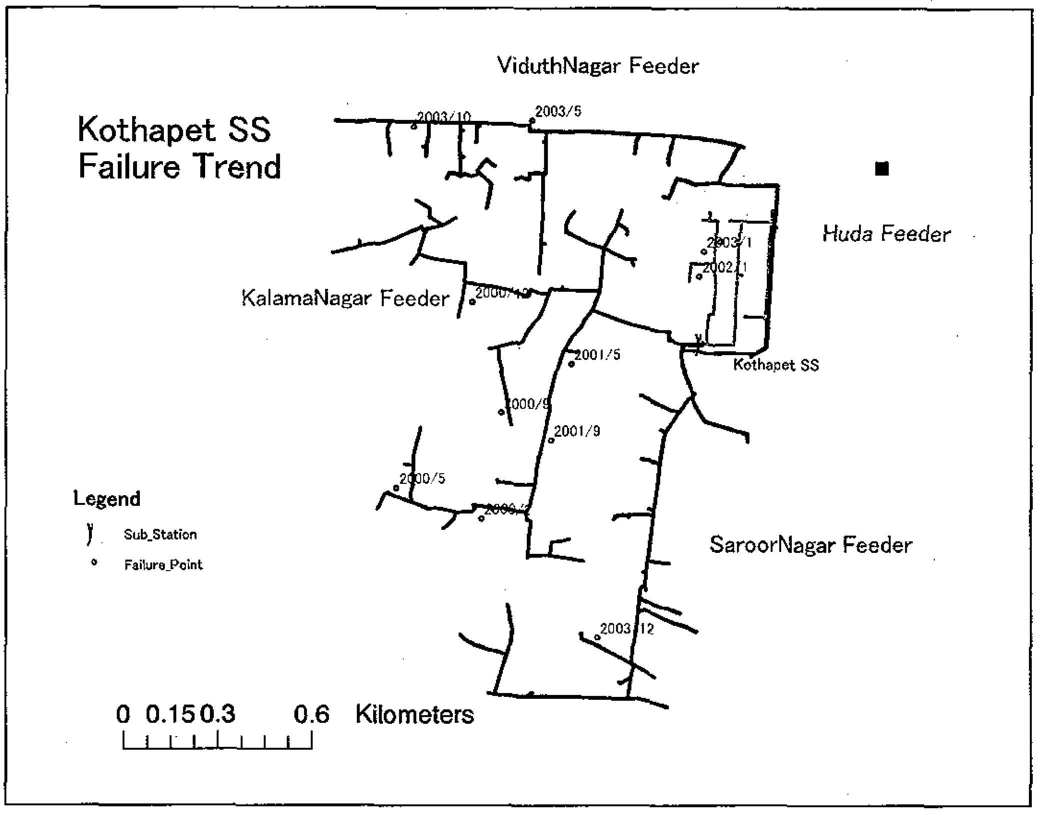


Figure 6.23 Example of failure trend

(3) Study Data for Electricity Supply Method

- There are sensitive customers for electric shut down. GIS can ease the management of the electric facilities to these customers such as hospital, HT customers and water facilities.
- GIS can assist in forecasting future demand in each region to analyze the history load data. This rate of demand increase is vital to plan expansion facilities in the future.

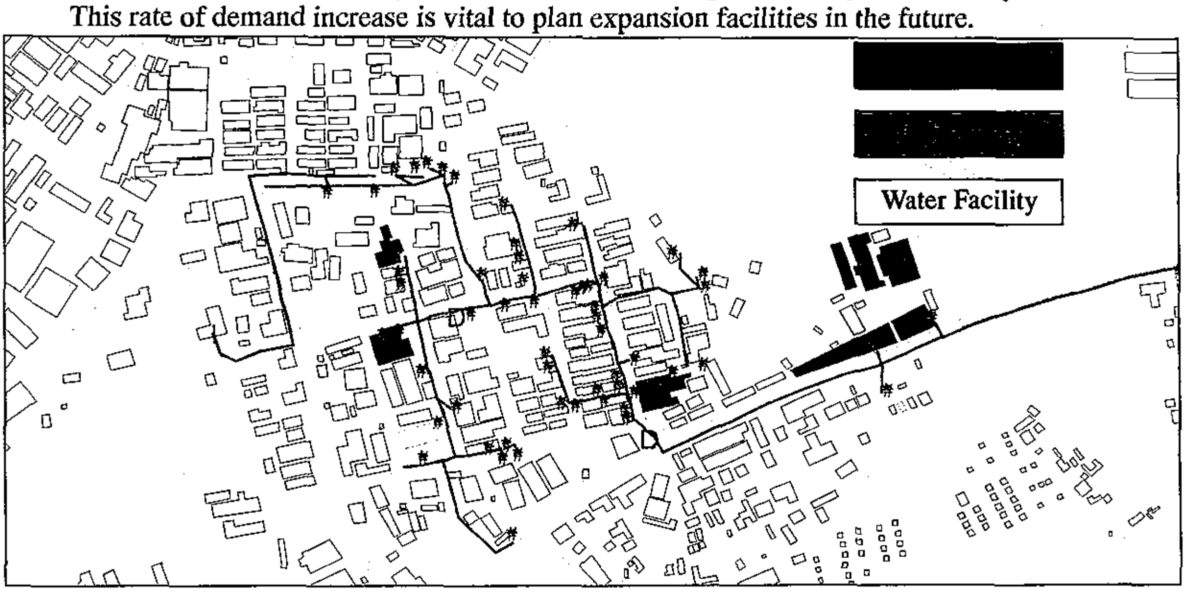


Figure 6.24 Example of priority customer map

6.8 GIS Expanding Plan

The study team introduced a GIS System to three selected substations. The study team expects that additional benefits such as labor saving for data management and customer sirvice will occur as the system is expanded to other surrounding areas. However, one stumbling block may be the need for locals to acquire the know-how to maintain and upgrade the changing data.

6.8.1 GIS Expanding Practice

After conducting OJT for the GIS system in the selected three offices, the study team accessed the staff's organization and the technical level. Since they currently manage facilities and customer data under the present system, these staffs are capable of taking on the responsibilities of GIS management through proper training.

It should be noted however that the cooperation from the consultant would be vital in expanding the GIS system – especially during the early development stages when efficient pre-designs will be necessary.

Furthermore, the supporting system will be required to integrate into the GIS system through a LAN network.

(1) Recommended GIS Organization

The office in charge of distribution facilities and customers is called "Section office." However, the study team recommends that the GIS system should be installed into the "Division office", which is in charge of supervision of the "Section office", due to its security and staff qualifications.

The creation of a new division, "GIS Manager", to work with the "Facilities manager" and "Customer manager" will be crucial to optimizing the sharing of the benefits of the GIS system.

In addition, consideration should be given to establishing a "GIS Help Desk" at APTRANSCO or APCPDCL in order to consider the future role of GIS and to solve the problems, which may occur in the Division offices.

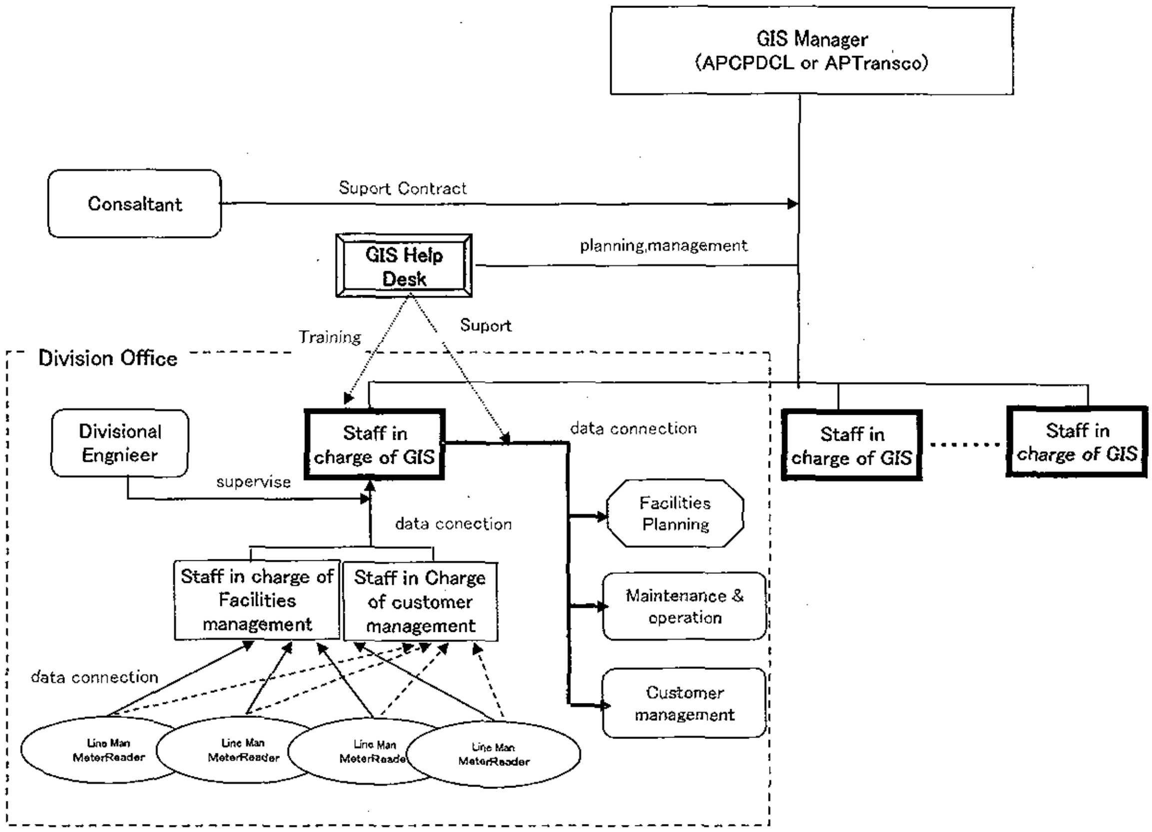


Figure 6.25 Organization for GIS expansion

(2) The Flow of Data Transaction

Distribution facilities and customer data should be revised for every occurrence of growth reflection, electric demand, and when new connections are made. Currently, when new customers visit the Section office, the staff must accompany them to the new connection site. This is due in part to the fact that distribution maps are not available and it is difficult to obtain the specific location from the address.

This system is not efficient and will benefit from the implementation of a GIS system. With a GIS-based database in place, the handling of new connections will be vastly improved.

GIS can also allow the Section to discontinue the creation of hand-drawn maps, with the built in mapping tools that GIS provides. Figure 6.26 shows the flow for present new connection and GIS introduction.

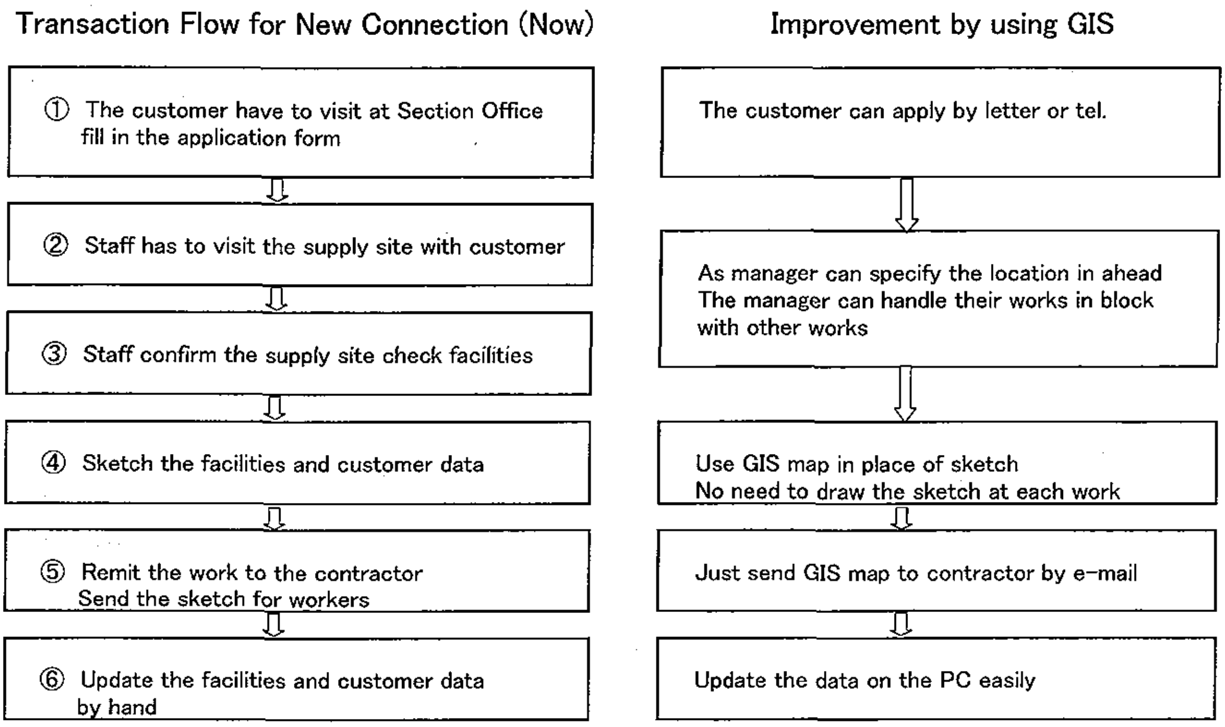


Figure 6.26 Flow for present new connection and GIS introduction

(3) Obtaining Benefit from GIS

(a) Sharing information between offices

As mentioned previously, the Division office is the most appropriate office to introduce GIS. The communication media between GIS and Section office are required to exchange the information. This is vital to fulfill the benefit of GIS. Since there are telephone lines at each Section office, it is possible to exchange information via fax.

(b) Restructuring of terminal office

Before introducing GIS, it is important to research the amount of work and evaluate cost effectiveness at each Section office. At this interview, the rate of new connections ranges from 5 to 6 a day at Kothapet, and only one at Medak and SangaReddy office.

It is possible to shift and consolidate the workload that the Section offices currently perform and centralize them at upper offices.

(c) Additional data for having a profound benefit

With the currently existing data (mentioned in Section 6.7), improvements to the current workflow have been realized. For example, knowing the number of poles, meters, and so forth. Moving to the next step, with the addition of the following data can lead to large benefits for managing the facilities data and managing new connection work.

(i) The year of manufacture of transformer

It is not difficult to collect the data of manufacturing year of transformer, as it is mentioned on the nameplate at the site. Managing this data at GIS enables us to show the aging situation of transformer visually on the display. This data is very useful for replacing an old transformer to prevent electric failure.

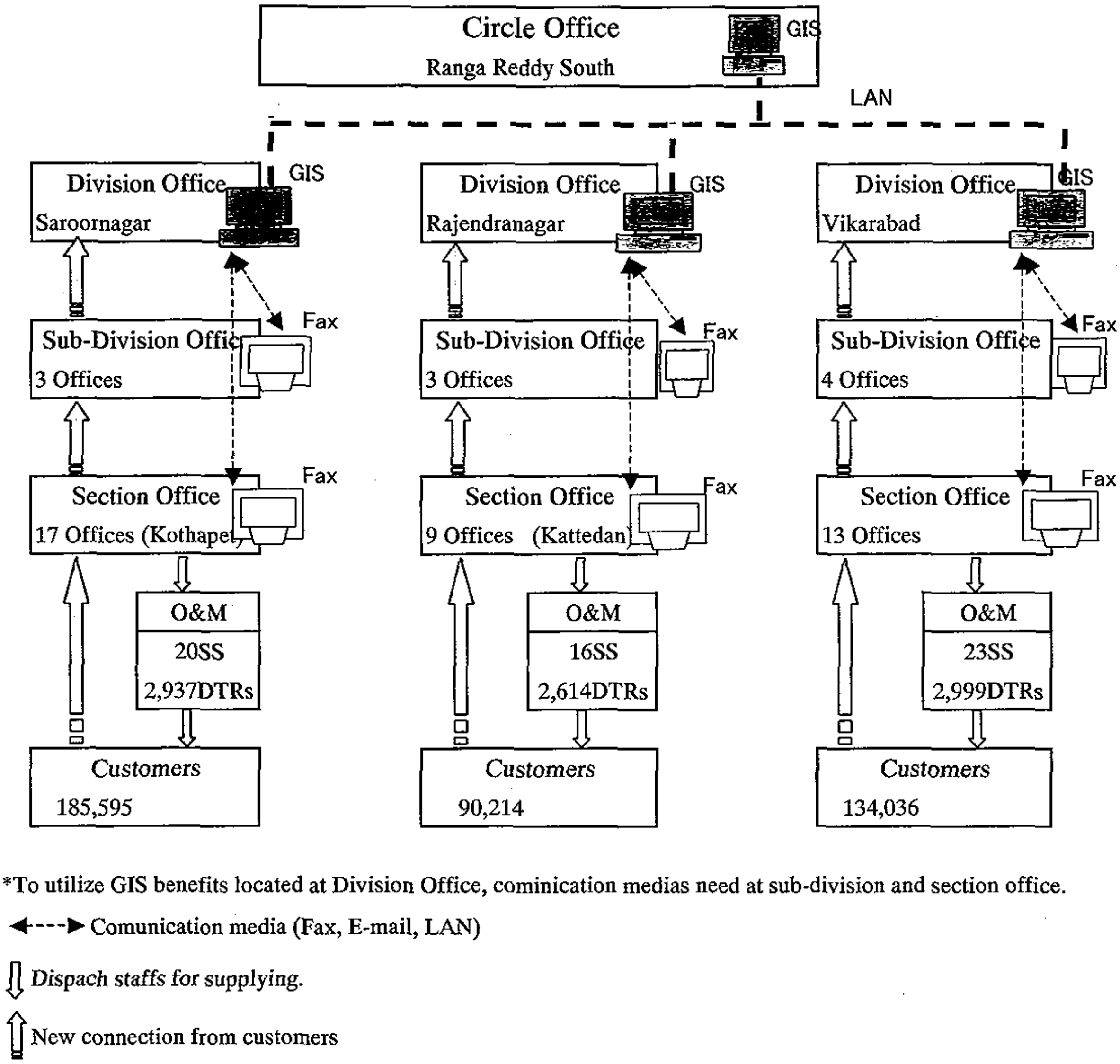


Figure 6.27 Communication network for GIS introduction

(ii) Distance from substation

When the staff installs new transformers, they check the availabilities from the index of "Distance from substation × Capacity of transformer"

Therefore adding the data of "Distance from substation" to transformer layer enable us to check the availability at a glance.

The distance from the substation can measured easily from the 11kV layer.

(iii) History data of transformer failure

Managing the history data of transformer failure in GIS is very useful to know the trend which transformers set off electric failure. Analyzing this trend, the manager evaluates the specification and replacement plan to prevent similar future failures.

(iv) Data related to cutting trees

The causes of many electric failures are earth fault by touching trees. Managing information of cutting trees enable managers to specify the place of high probability of failure. Utilizing this data it is possible to plan site investigation effectively to reduce the amount of supply cutting.

(v) Data related to customer consumption

Since consumption data is needed to update all metering, it is tough work to input this data and update the real time data. APTRANSCO are currently creating a Customer Management System to be used in the near future – management of customer data will be utilized by this system. Therefore, there is no need to input the consumption data into GIS, as GIS is only used to assist in analyzing the consumption data only when it is required. The details of the CMS (Customer Management System) are mentioned in next section.

6.8.2 Collaborations with CMS

APTRANSCO are considering the introduction of a CMS system in order to avoid power theft and to operate proper billing using domestic financial resources, called APDRP (Accelerate Power Development and Reform Program).

This CMS system consists of six components listed below. APTRANSCO plans to introduce this system for their customer center to encourage the improvement of customer service and efficiency data management regarding customer. The study team believes that the GIS will compliment the CMS system.

- New Connection
- Metering
- Billing
- Collection
- Disconnection & Dismantlement
- Customer Service

The study team studied whether the data should be entered into GIS or not? The study team concluded that the data related to customer should be managed by the CMS, and linking the GIS positioning data to CMS is the best way to have synergistic effects.

6.8.3 Human Resources Development for GIS Introduction

To input new data and update them accurately it is very important for the GIS to maintain reliable data. Therefore, introducing it properly requires the establishment of the appropriate human resources development program along with an efficient organization.

The study team conducted OJT training in India. GIS managers need to be trained by attending the seminar or training program held by the consultant for the foreseeable future.

The training will provide the ability for each manager to handle the GIS system independently and properly.

The attendees of the training programs should have qualifications, and expect to be key people for GIS at their office.

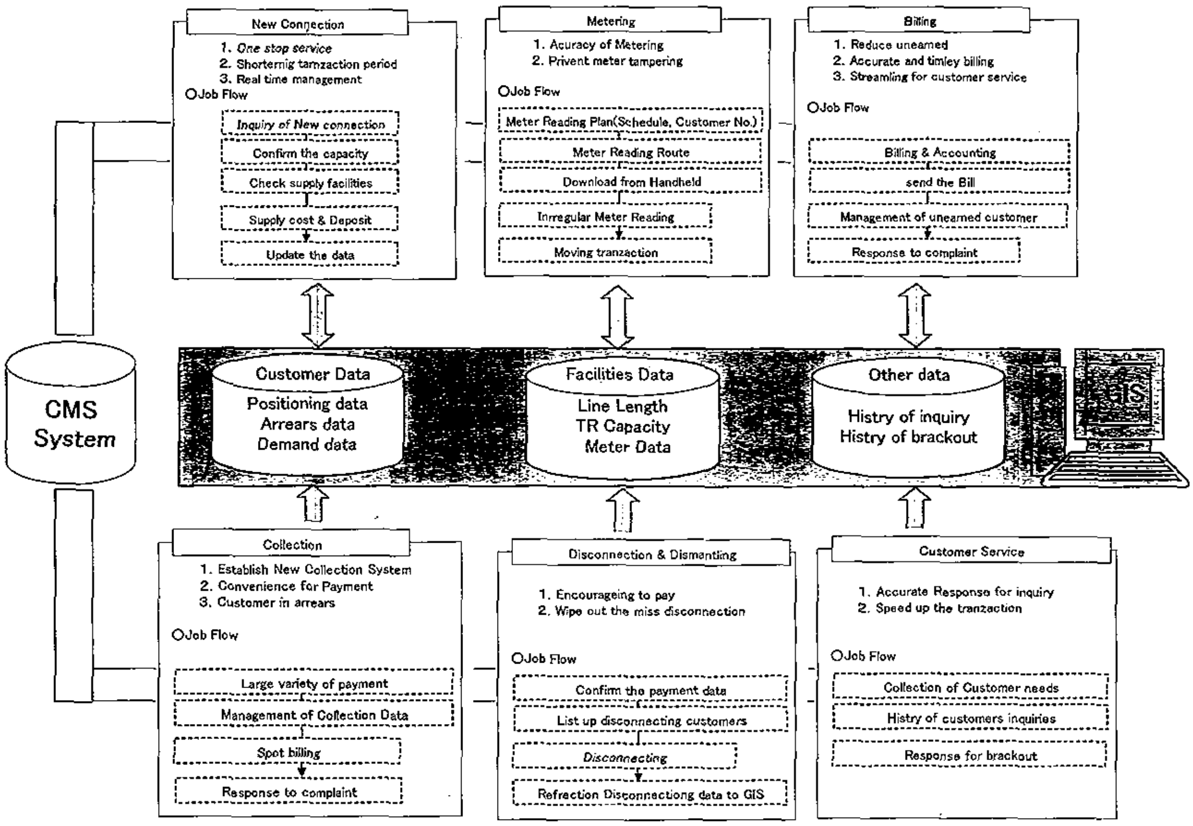


Figure 6.28 Collaborations with CMS

6.8.4 Area of GIS introduction

At present, a detail map that shows residential areas and public facilities is not approved on the market due to restrictions by the India's Defense Ministry. Because the map cannot be sold in large quantities on the market, the price for high quality maps is very high. However, there is no residential map in India - only maps that show major roads, highways, and big public facilities at a 1:5,000 scale are available. Moreover, of the selected areas, only Hyderabad has a detail map with 1:5,000 scale. As for the district level, there is no detail map. Only major roads and highways are shown in the map and scale is 1:200,000. It is difficult to use this map for the distribution GIS map because of lack of information. Considering the availability of maps, the procedure of expansion for distribution of GIS should follow this step.

First stage : Hyderabad

Second stage : Ranga Reddy district

Third stage : Surrounding districts of Ranga Reddy

In this report, the study team proposes the first stage plan in detail.

6.8.5 Necessary Manpower for GIS Creation

In this study, the study team created a distribution GIS for three target feeders supported by the Indian counterparts.

1) Positions of poles for 11kV line and distribution transformers were checked by using a printed map or GPS.

2) Entering the above data into the PC for each 11kV line.

3) Checking the positions of LT poles and customer locations using the printed map or GPS.

4) Entering the above data into the PC for each customer position.

Manpower required for these surveys are as follows.

- 11kV line survey: four people/day-one feeder
- Data input for 11kV line: one person/day-one feeder
- Low voltage line and customer survey: one person/day-one Distribution Transformer
- Data input for low voltage line and customer: one person/day-one Distribution Transformer

There are three circle offices (Hyderabad North, Hyderabad South, Hyderabad Central) in Hyderabad and they are managing 64 substations (Refer to table 6.5). The number of total feeders in Hyderabad is 421 and average feeders at each substation are 6.6 feeders. In general, one feeder has 30 to 50 distribution transformers. Therefore, it is estimated that the number of total distribution transformers in Hyderabad is 17,000.

From the number of existing facilities (number of feeders and number of Distribution Transformer) and the results of our survey, the necessary man-months for the creation of the distribution GIS in Hyderabad is as follows. Table 6.6 shows the necessary man-months for data collection.

Table 6.5 List of 33/11kV substation in Hyderabad

Sl. No	Name of the sub-station	33/11 KV transformers each substation		No. of feeder
		Nos	Capacity (No. x MVA)	
HYDERABAD NORTH				
1	AIRPORT	2	2 x 8	6
2	ALLWYN	2	2 x 8	8
3	BANJARA HILLS	2	2 x 8	6
4	BEGUMPET (No.12)	2	2 x 8	8
5	BOWENPALLY	2	2 x 8	6
6	CLOCKTOWER	3	2 x 8 + 1 x 7.5	4
7	FILM NAGAR	2	2 x 8	6
8	GREENLANDS	2	2 x 8	4
9	GYMKHANA	2	2 x 8	4
10	HAKIMPET	2	2 x 8	4
11	HAL	2	2 x 8	6
12	HMT	2	2 x 8	5
13	IDPL	6	3 x 8 + 1 x 5 +2 x 3.0	9
14	JAMES STREET	2	2 x 8	6
15	KALYAN NAGAR	2	2 x 8	8
16	LALAGUDA	3	1 x 8 + 2 x 5	5
17	MADHAPUR	2	2 x 8	5
18	MAITRIVANAM	2	2 x 8	6
19	MARREDPALLY	2	2 x 8	6
20	MOTHINAGAR	2	2 x 8	6
21	NIMS	3	3 x 8	10
22	NEHRU NAGAR	1	1 x 8	4
23	OSMANIA UNIVERSITY	2	1 x 5 + 1 x 7.5	4
24	PATIGADDA	3	3 x 8	6
25	PRAGA TOOLS	2	2 x 8	4
26	R P NILAYAM	2	1 x 8 + 1 x 7.5	4
27	RD. NO2 BANJARA	2	2 x 8	6
28	SEETAPHALMANDI	2	1 x 8 + 1 x 5	5
29	SRINAGAR COLONY	2	2 x 8	6
30	YOUSUFGUDA	2	1 x 8 + 1 x 5	6
31	GUNROCK 132/33/11	2	2 x 8	8
32	JUBILEEHILLS 132/33/11	3	2 x 8 + 1 x 16	8
	TOTAL	72		189
HYDERABAD SOUTH				
33	ASMANGADH	2	2 x 8	6
34	ATTAPUR	2	2 x 8	4
35	CHANCHALGUDA	3	3 x 8	6
36	CRPF	2	2 x 7.5	6
37	E N T HOSPITAL	2	2 x 8	6
38	FALAKNUMA	3	3 x 8	6
39	KANCHANBAGH	2	2 x 8	6
40	KARWAN	2	2 x 8	4
41	KHILWATH	2	2 x 8	6
42	MALAKPET	3	3 x 8	8
43	MIRALAM	3	3 x 8	7
44	MOOSARAMBAGH	2	2 x 8	6
45	OSMANIA HOSPITAL	3	3 x 8	8
46	SALAJUNG	3	3 x 8	7
47	SANTOSHNAGAR	3	3 x 8	7
48	SEETARAMBAGH	3	3 x 8	6
49	SULTANBAZAR	2	2 x 8	5
	TOTAL	42		104
	HYDERABAD CENTRAL			
50	AC GUARDS	3	3 x 8	8
51	AMBERPET	2	2 x 8	6
52	ASIFNAGAR	3	3 x 8	10
53	BATHKAMMA KUNTA	2	2 x 8	6
54	CHIKALGUGA	3	3 x 8	7
55	EXHIBITION GROUNDS	3	3 x 8	8
56	GOLCONDA	2	2 x 8	7
57	HUSSAINSAGAR	7	4 x 15 + 3 x 7.5	26
58	HYDERGUDA	2	2 x 8	6
59	INDIRA PARK	3	3 x 8	10
60	INDUSTRIAL AREA	3	3 x 8	10
61	LAKE VIEW	2	2 x 8	6
62	NARAYANAGUDA	2	2 x 8	6
63	PUBLIC GARDEN	2	2 x 8	6
64	S D HOSPITAL	2	2 x 8	6
	TOTAL	41		128
	GRAND TOTAL	155		421

(Source) APCPDCL

Table 6.6 GIS necessary man-months for GIS creation

item	Man - day	Man-months
Site survey for 11kV line	421feeder×4 people/day-feeder=1,684 persons/day	84
Data input for 11kV line	421feeder×1 person/day-feeder=421 persons/day	21
Site survey for LT line	17,000 DTR×1 person/day-DTR=17,000 persons/day	850
Data input for LT line	17,000 DTR×1person/day-DTR=17,000 persons/day	850
Total		1,805

(The working day for month is 20 days of one month)

The GIS mapping for 425 feeders is to be completed during the first year. The positioning survey of the 11kV poles and the distribution transformers will be conducted by two feeders a day.

From the second-year to the fifth-year, the customer data will be entered into a PC. There are more than 17,000 distribution transformers in Hyderabad. The positioning survey for the customers and LT poles should be conducted by a schedule of 20 transformers a day. Man-months required to complete the customer survey will be great.

6.8.6 Main Equipment for GIS

The GIS system should be managed by the "Division Office", which is in charge of supervision of the "Section office", due to its security and staff qualifications as mentioned in section 6.8.1. There are nine Division offices in Hyderabad. When two desktop computers for the distribution GIS are setup in one office, 18 computers and 18 GIS licenses are necessary. Moreover, it is necessary to store data in Database Management System (DBMS) such as Oracle, Microsoft SQL Server, Informix, and IBM DB2. To connect this PC storing the DBMS to each Division office in the network, an application server is also necessary (for instance, ArcSDE).

In addition, to display the distribution GIS on a website, the software for website publishing is also required (for instance, ArcIMS).

The digital map of Hyderabad (with the coordinate system) is necessary for the distribution GIS. At present, the digital map of Hyderabad is available and its scale is 1/5,000.

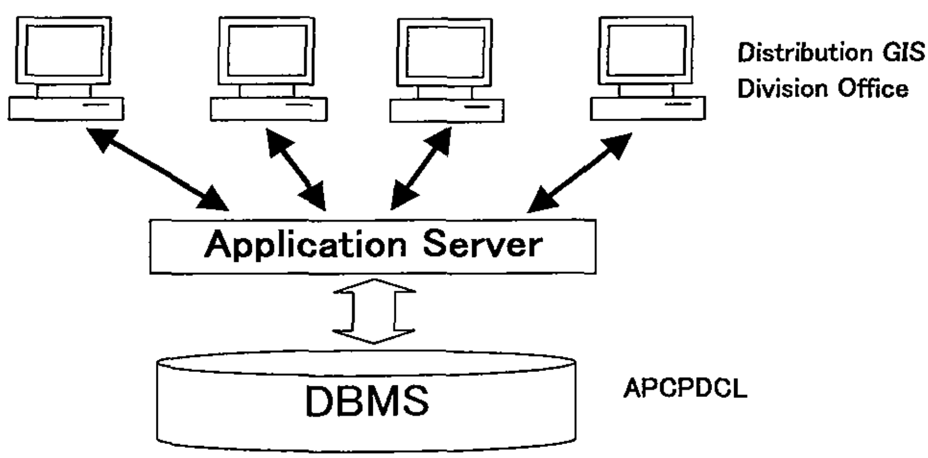


Figure 6.29 Image of GIS network

Table 6.7 Lists of main equipment for GIS

Equipment		Qty
Desk Top Computer	17 inch monitor	18 sets
Database Management System (DBMS)	Oracle, Microsoft SQL Server, Informix, IBM DB2, etc.	1 set
Software for GIS		18 licensees
Software for GIS Application Server		18 licensees
Software for Internet Web		1 set
Digital Map	Scale (1:5,000)	1 set

6.8.7 Necessary Cost

Necessary costs for creating the distribution GIS in Hyderabad are the consultant fee and personnel expenses for the data collection besides hardware and software of PC. The GIS team in APCPDCL needs many temporary employees because the data collection for positioning survey of facilities and customers will be completed by a large staff in a short period. Necessary man-months for five years are about 1,800 man-months. When the study team estimates 4,000 rupees/man-month (US$100/mon-month), total cost for five years reaches 7.2 million rupees (US$180,000).

Moreover, consultant fee is thought to be 500,000 dollar- 1,000,000 dollars for one year considering average projects costs such as the World Bank and the Asia Development Bank.

Table 6.8 shows total estimate costs for the distribution GIS creation.

In addition to the above-mentioned costs, additional equipment such as facsimiles (for communication between Section office and Division office), printers for PC, and other administration costs will be incurred. Costs for the entire project is about six million dollars.

Table 6.8 Total estimate costs for distribution GIS creation

Description	Qty	Unit Cost (US$)	Total Cost
Digital Map	1 set	50,000	50,000
Desktop Computer	18 sets	2,000	36,000
DBMS	1 set	4,000	4,000
Software for GIS	18 sets	4,000	72,000
Software for GIS Application Server	18 sets	10,000	180,000
Software for Internet Web	1 set	30,000	30,000
Other Software (MS Office, etc)	18 set	1,000	18,000
Expenses for data collection	1,800 MM	100	180,000
Consultant Fee	5 years	1,000,000	5,000,000
Total			5,570,000

The above-mentioned cost is rough estimate cost for GIS in only Hyderabad.

In the case of GIS expansion to other districts, a detail digital map with the coordination system will need to be created since there is no large-scale digital map in the district level at present - thus additional costs will be required.

In Japan, a detailed residential map has already been marketed and GIS has been used in various fields such as electricity, telecommunication, water supply, etc.

To expand GIS in India, deregulation for sales of maps and its circulation in commercial market are necessary.

6.8.8 Schedule of GIS Creation

Table 6.9 shows the work schedule of the distribution GIS creation in Hyderabad.

Feeder GIS of each substation is created in first year and the customer database is constructed during second year to fifth year as mentioned before.

1) Firstly, it is necessary to establish the GIS team in APCPDCL. The organization chart is mentioned in Section 6.8.1(Refer to Figure 6.25).
2) Next, a large number of temp-staff will be required to survey all utility poles, transformers and the customer positions. Therefore, they need to train for unifying the investigation methods before the start of surveying. There is a possibility of lack of data when making the attribute table if the investigation methods are not unified.
3) After decision of the investigation methods, the position of facilities (utility pole and transformer, etc.) is confirmed by site survey. There are numerous landmarks in Hyderabad. They can use the printed map and plot on the map.
4) Following the site survey, they must record the facilities information such as feeder size, transformer capacity, manufacturing year of transformer, the distance from the substation to each transformer, and the accident record etc. from the equipment ledger.
5) After position and equipment information are completed, the data is entered into a computer. As for facilities' information, it is necessary to define the format of the attribute table of GIS.
6) After entering data, the consultants will check the data.
7) The staff of the GIS team in APCPDCL should regularly attend training from the consultants.

Table 6.9 Work schedule of distribution GIS creation in Hyderabad

	1st year	2nd year	3rd year	4th year	5th year
(1) Establishment of GIS section in APCPDCL	■				
(2) Training for location survey of feeder to temporary employees	■				
(3) Location survey for all feeder	■				
(4) Data collection for information of DTR & Line	■				
(5) Entering feeder data into PC	■				
(6) Data check by consultants	■	■	■	■	■
(7) Staff training by consultants	■ ■	■ ■	■ ■	■ ■	■ ■
(8) Training for location survey of customers to temporary employees		■	■	■	■
(9) Location survey for all customers in Hyderabad North		■	■		
(10) Location survey for all customers in Hyderabad Central				■	
(11) Location survey for all customers in Hyderabad South					■
(12) Data collection for customers' information		■	■	■	■
(13) Entering customers' data into PC		■	■	■	■

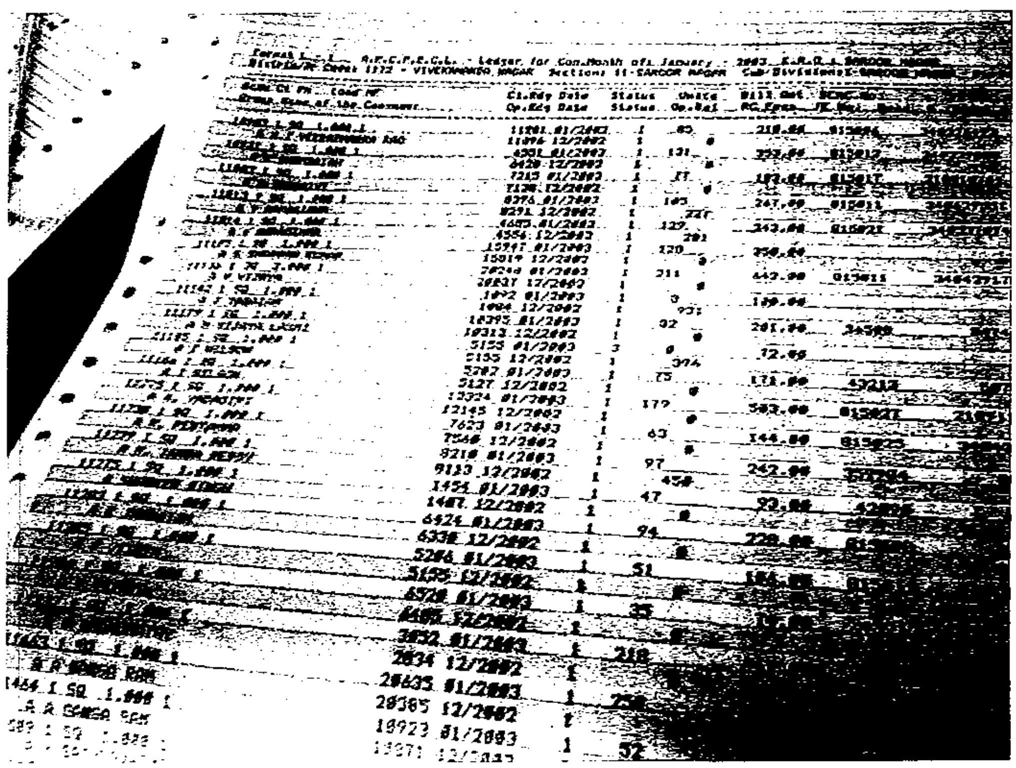
6.8.9 Future Application of GIS System

GIS systems recently being used in Japan are connected to the host computer via LAN and integrated with other systems in the firm. To fully utilize GIS, the location data of GIS should be connected to other system that handles new connection, designing, contract for works, and facilities maintenance and so on. This data sharing optimizes the total effectiveness of the office operation.

Figure 6.27 displays the example image of a GIS system in Japan. The expansion plan for GIS should be considered as one of crucial programs in the electric utility business.

In this study, the study team examined the GIS introduction in the central power distribution company in the Andhra Pradesh. The distribution power company downloads customers' data from the hand-held computer and is managed by the Electricity Revenue Office (ERO). These management items are service number, power demand, electricity charge, default of payment, the date of the contract, etc. The data is represented by the figures as shown in Photograph 6.1. By moving the data into GIS, it is possible to find the location of each facility and customer. Moreover, it is possible to retrieve a large demand region easily. In the analysis of the regional trend of electricity demand, the power distribution company can make an effective expansion plan.

By customizing the GIS, it is also possible to calculate the technical loss between arbitrary points instantaneously by inputting the specification data of the power line and the transformer. The support of a professional consultant is necessary for this customizing. GIS not only helps to confirm the locations of customers and the facilities, but also is useful in improving the distribution network plan. It is difficult to measure the exact benefit of GIS introduction. However, the study team proposes to introduce the distribution GIS into APCPDCL step by step for an effective management of distribution network.



Photograph 6.1 Meter reading book of ERO

6.9 Recommendation

In this study, the study team proposed GIS introduction in APCPDCL for the management of distribution facilities and customers. Following items are our recommendations before the GIS introduction.

(1) Unified data format for management

At present, customer data and facility data such as transformer, distribution line and so on are managed in each section office and substation. Each office decides these management items and there is no common format for all offices. It is necessary to unite the management items for sharing information.

(2) Establishment of GIS organization

In this study, a prototype of the distribution GIS was created by the study team and Indian counterpart together. When a company introduces the GIS for management of power distribution system, every day you must update data for new customer, new installation, and modification of facilities. This work volume is very big. Therefore, it is necessary to establish new organization for the GIS management as shown in Figure 6.22.

(3) Report system

If a company set up a computer for GIS in all substations and Section offices, enormous cost and a lot of staff trainings are necessary. Therefore, the study team proposed to set up the GIS at Division office level. However, data for GIS come from substations and Section offices every day. So, it is necessary to create the workflow to transmit such data from substations and Section office to Division office.

(4) Training for PC operator

Staffs that are operating a personal computer in ERO and Division office have a possibility to resign the company because a lot of contract workers are operating a computer in the office. Hereafter, many employees have a chance to use a personal computer. It is necessary to have computer training for staffs.

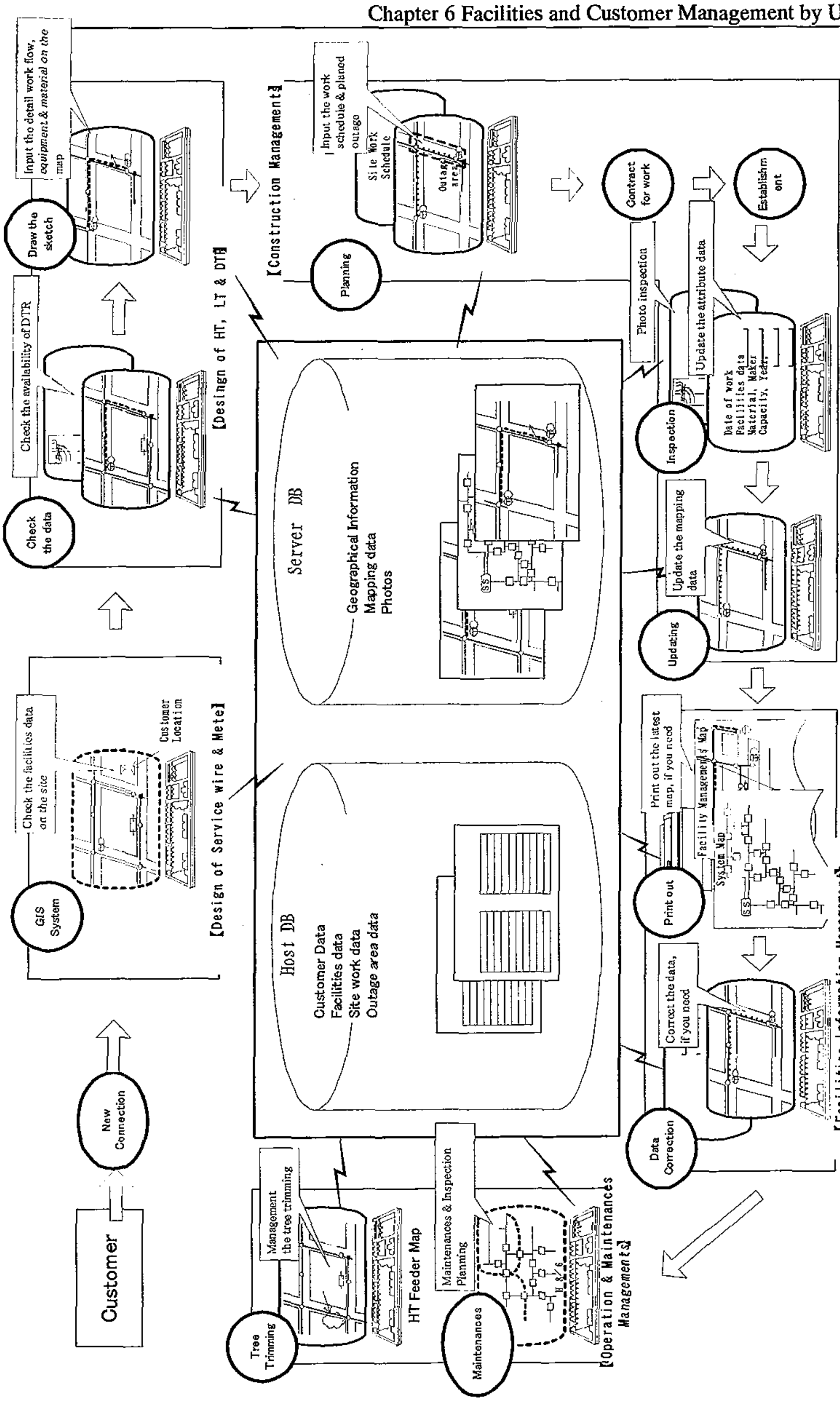
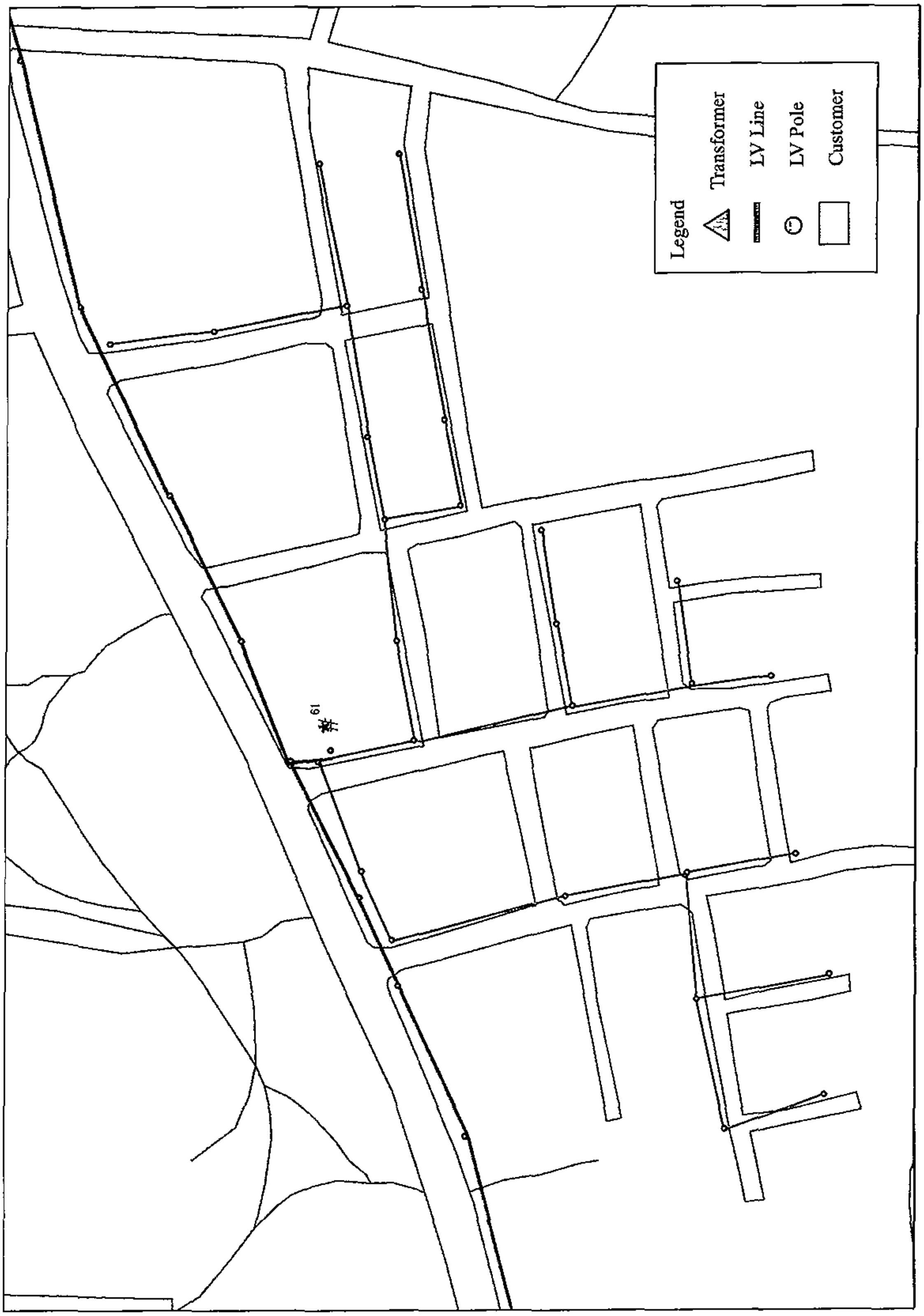


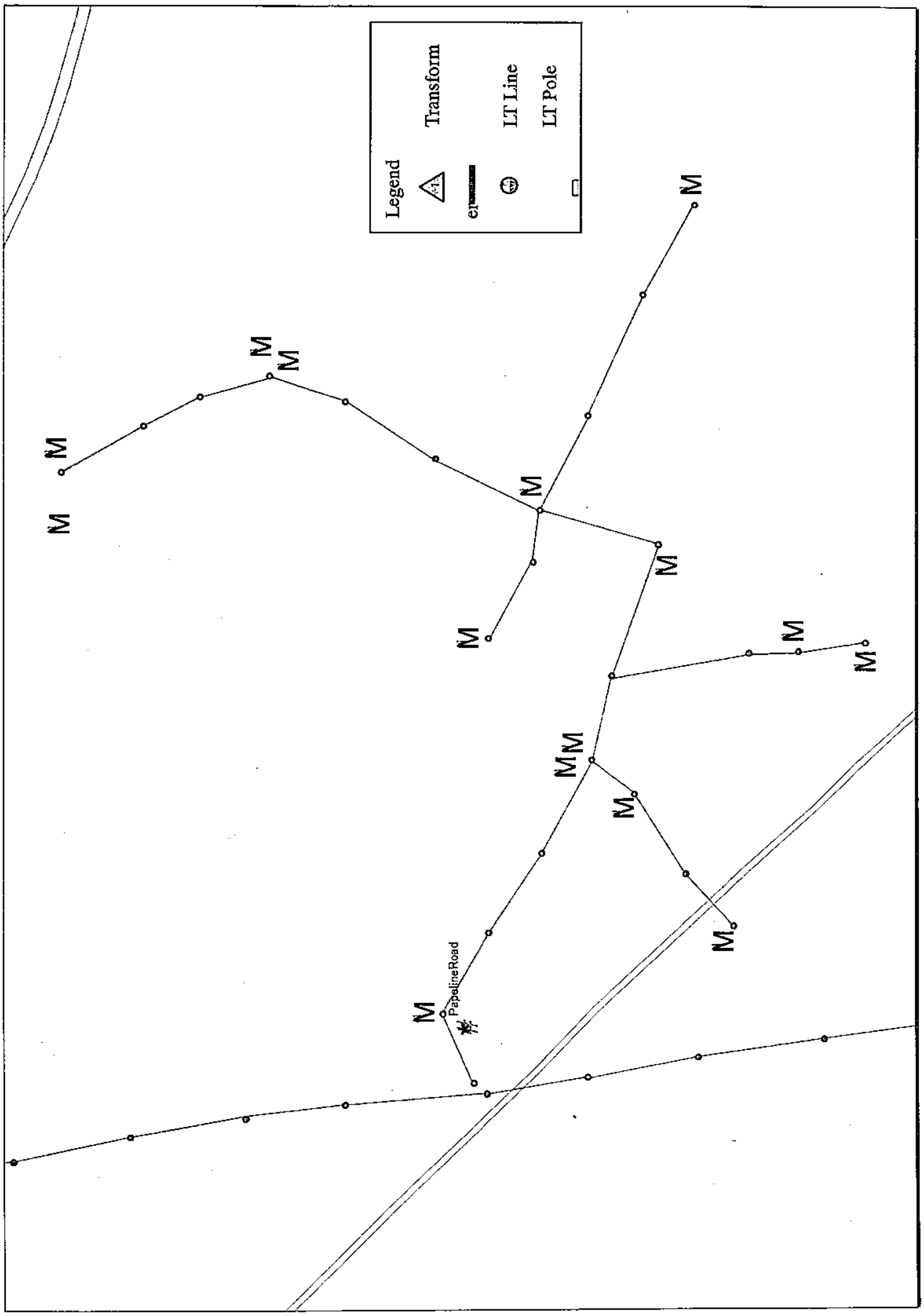
Figure 6.30 Image of GIS

Attachment

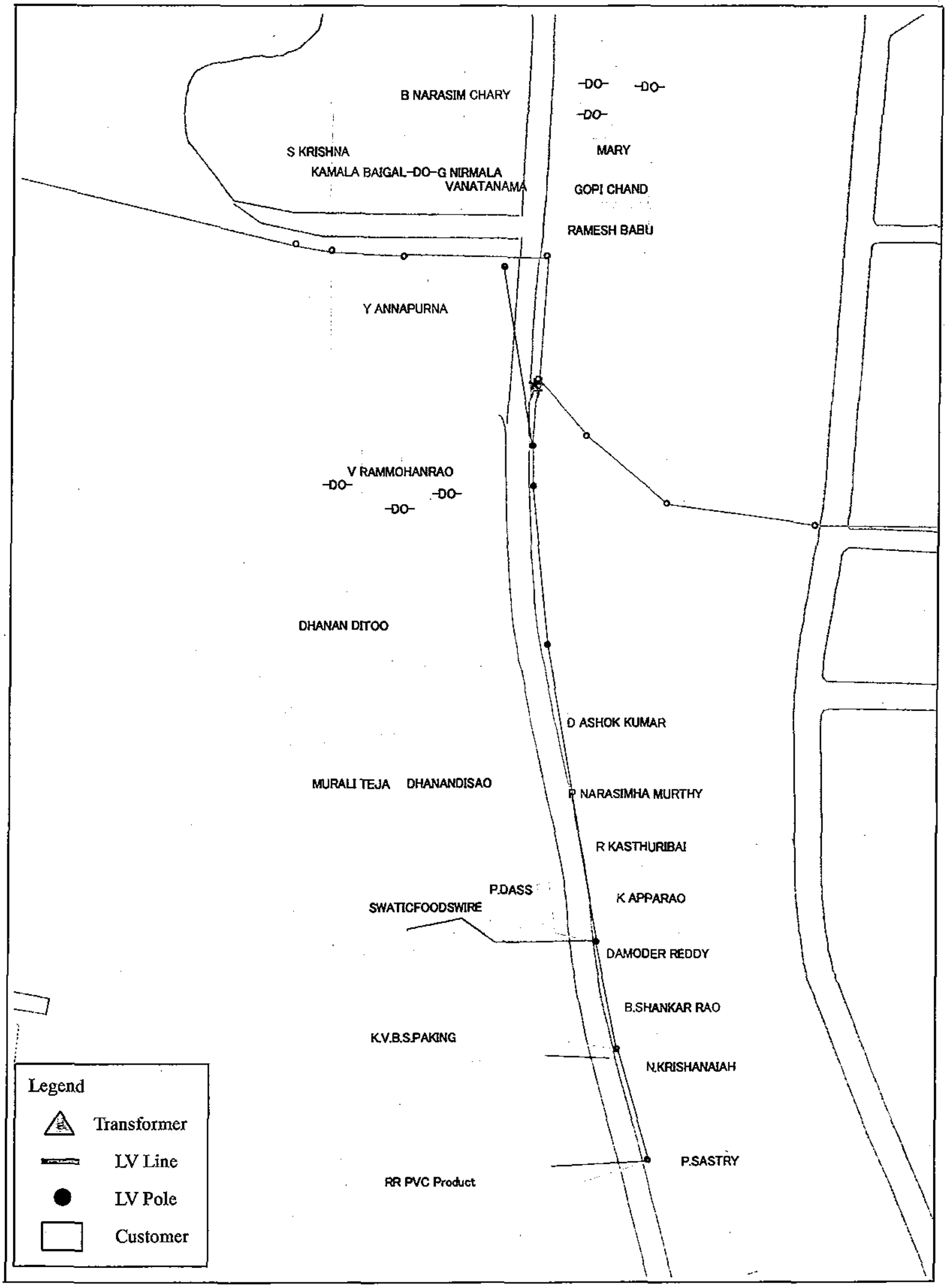
GIS Map for Target Feeders



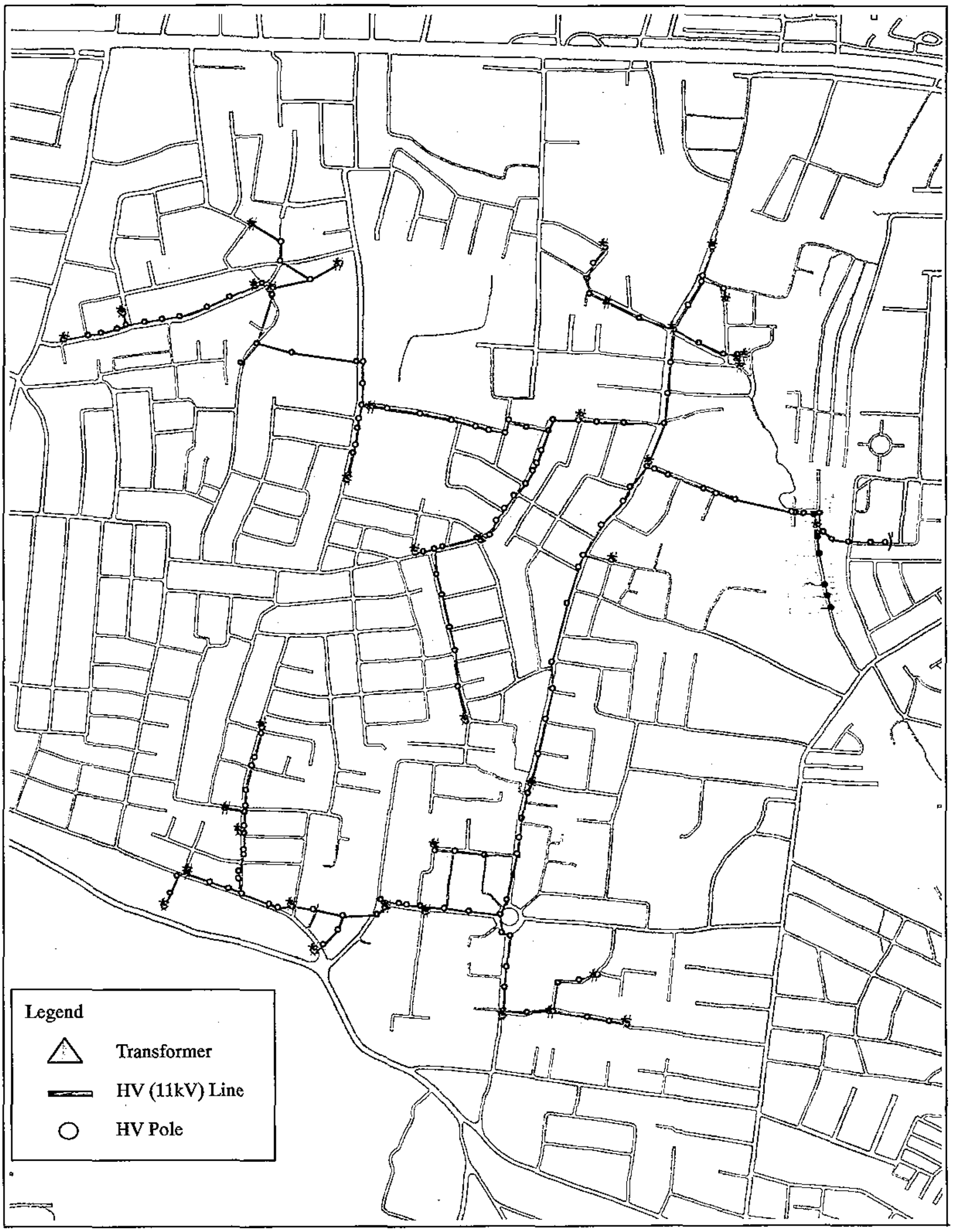
Kattedan Substation : Location of customers from No.61 DTR



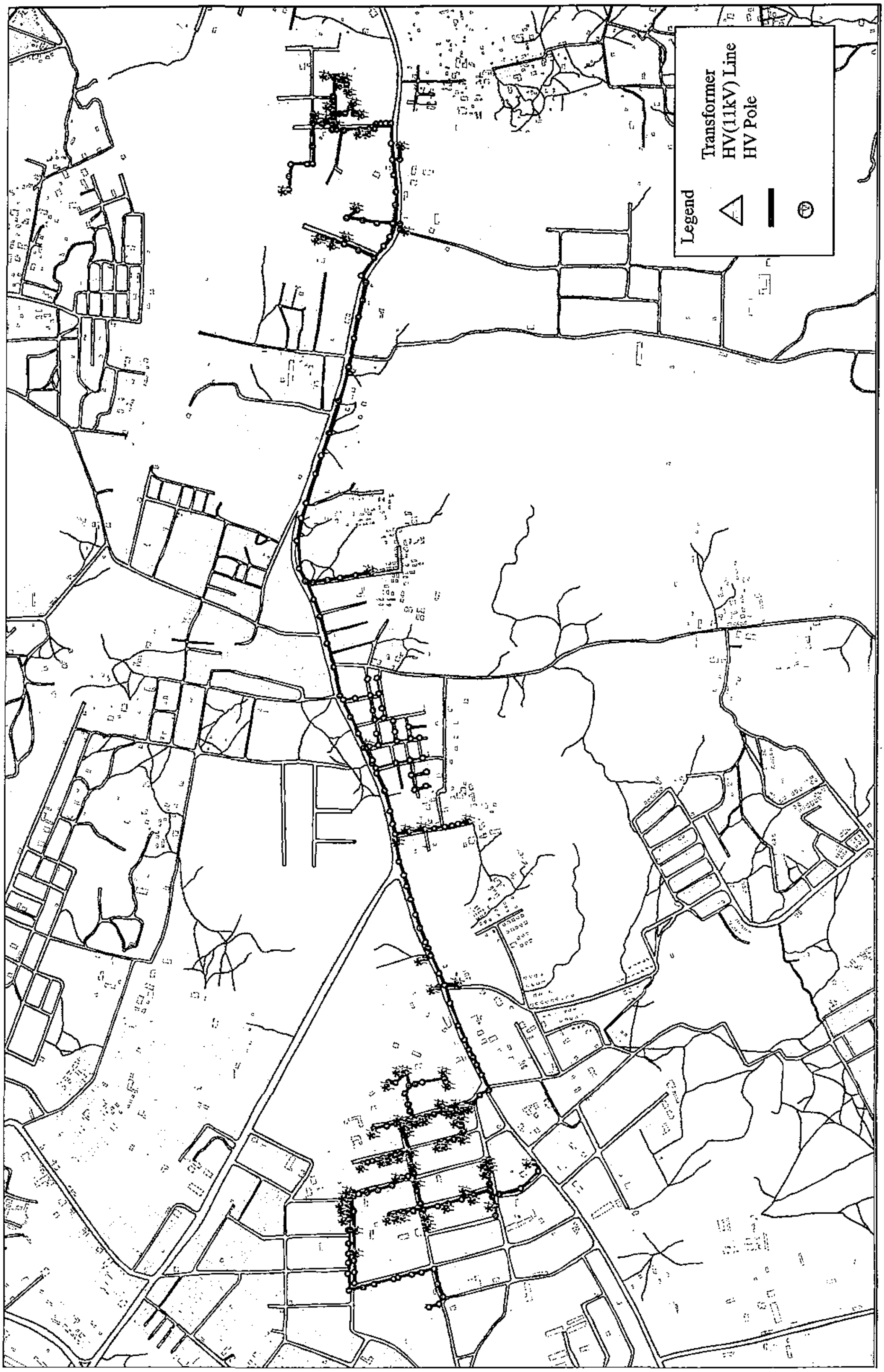
Malkapur Substation : Location of pump sets from pipeline road DTR



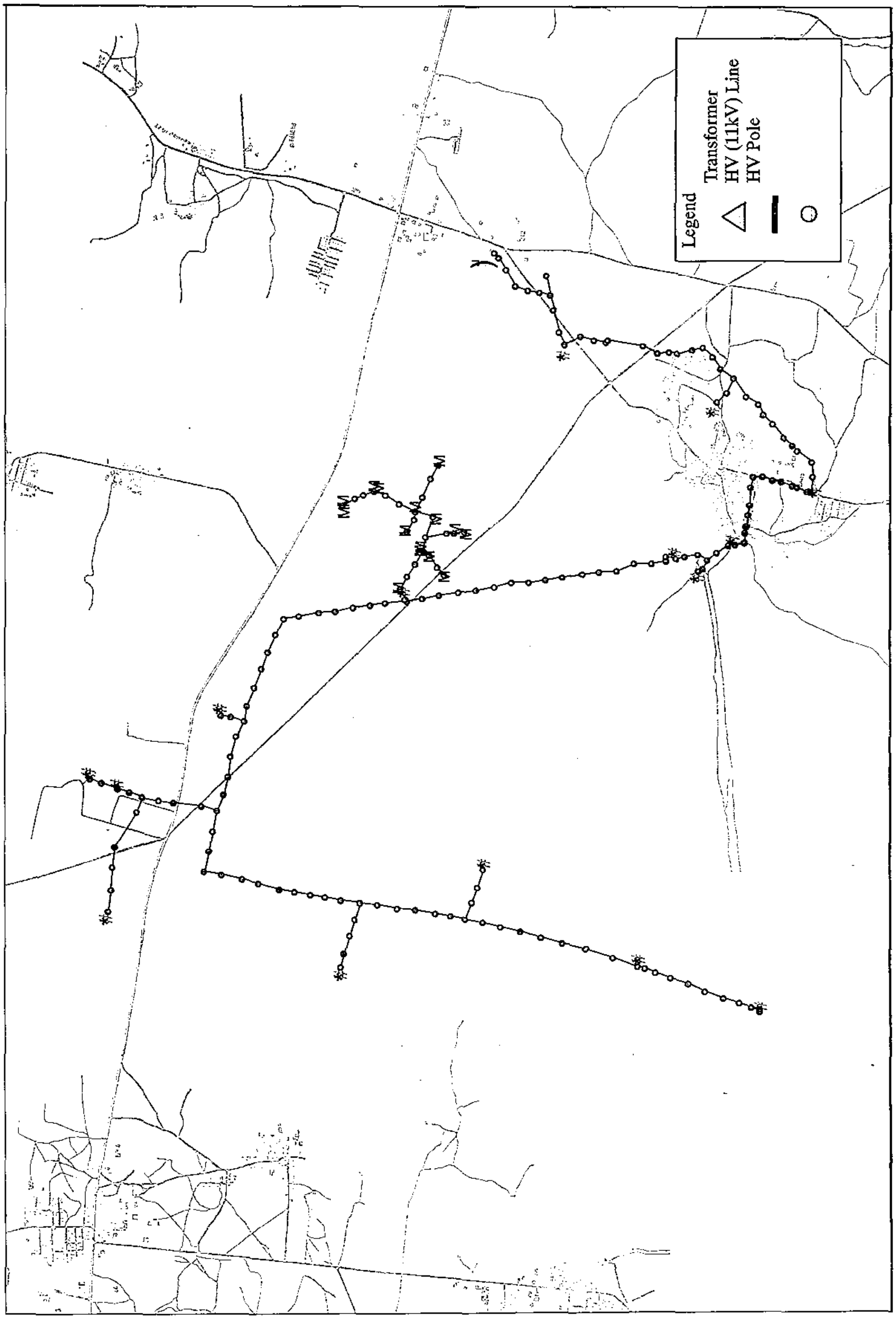
Kothapet Substation : Location of customers from KN-1 DTR



Kothapet substation : Kalamanagar feeder



Kattedan Substation : No.2 feeder



Malkapur substation : Malkapur feeder

Chapter 7 Training Facilities and Program

Contents

Chapter 7 Training Facilities and Program

7.1 General

This chapter explains the "Training Programs for Distribution Network," which was decided based on the results of the investigation of the current conditions of the training facilities owned by APTRANSCO and APCPDCL, their training programs, and future expansion plans.

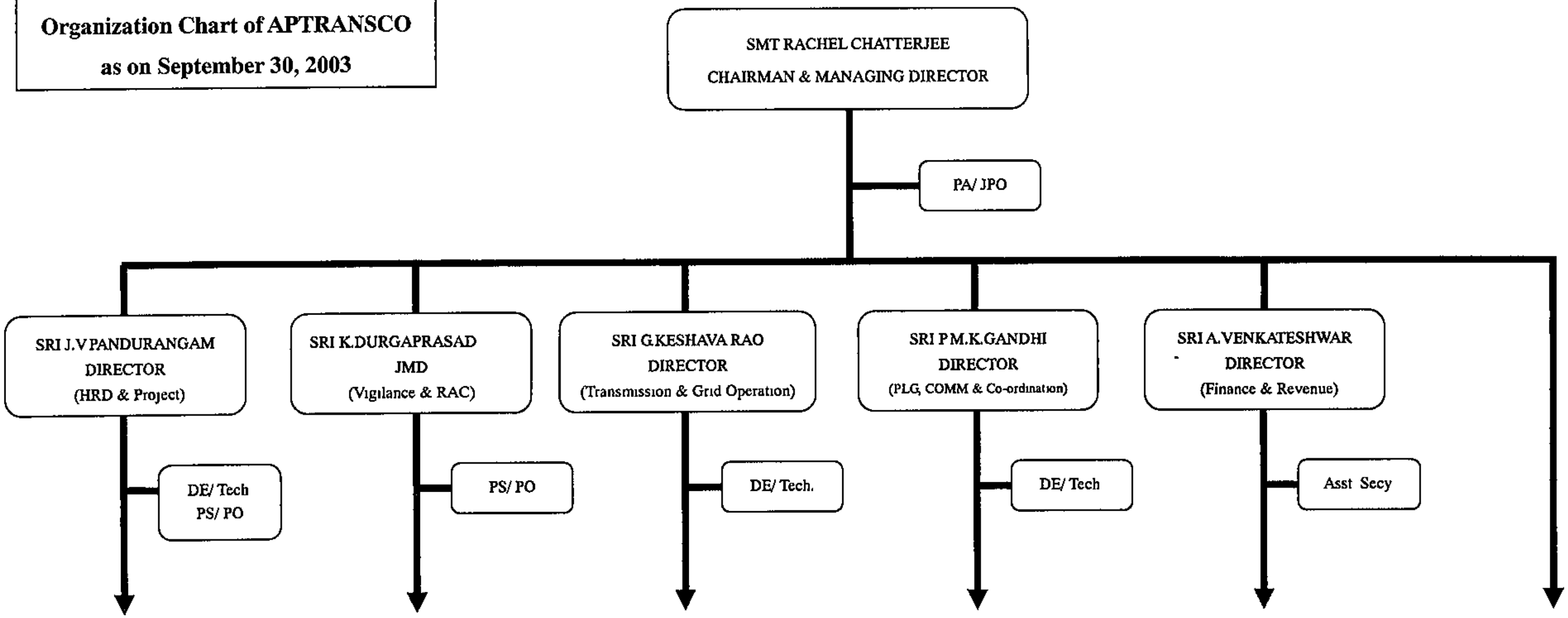
In addition, for the "Training Programs for Distribution Network," to solve problems of the maintenance and management of the distribution facilities in APTRANSCO and APCPDCL, effective solutions from Japan's technology are extracted, and the program aims to aid the transfer of this technology.

7.2 Current Conditions of Training Facilities

7.2.1 Corporate Training Institute (CTI)

- CTI was established in 1991 to train non-workers, who are engineers, accounts staff and administration staff.
- In the Human Resource Department and Projects of APTRANSCO, the Training and Planning Section are managed by one Chief Engineer (C.E.). CTI belongs to the training section of APTRANSCO.
- In organization, CTI belongs to APTRANSCO, and four distribution companies that are called "DISCOMs" composed of CPDCL, NPDCL, EPDCL and SPDCL. These share the working expenditure equally.
- CTI accepts trainees from the above five companies and trains them.
- As training facilities, there is a lecture hall composed of two large and one small hall, a computer laboratory, a dining hall and a hostel block.
- The total number of CTI staff is around 35 persons.
- In the technical section of CTI, there are two Divisional Engineers (D.E.) under a Superintending Engineer (S.E.). D.E Training is responsible for "course coordination without a computer course" and D.E Training & Development is responsible for computer courses and planning the programs, course materials and coordinating for sending the staff for out side CTI training.
- Each D.E manages two Assistant Divisional Engineers (A.D.E.) who are called T.O.T. (Technical Officer Training) I, II, III and IV.
- There are five acres of the CTI site.
- The organization chart of APTRANSCO and CTI are shown in Figure 7.1 and Figure 7.2.
- The operation system for the computers in the computer laboratory is "Windows 2000." The specifications for these computers are shown in Table 7.1.

Organization Chart of APTRANSCO as on September 30, 2003



Dual Control

1 CE/Civil - Director (HRD & Projects) and Director (Trans & G O)
2 CE/Operation - Director (Planning, C&C) and JMD (Vig & RAC)
3 CE/Comml & IT - JMD (Vig & RAC) and Director (Planning, C&C)
4 Supnt Enggs/DPE and Assessments - JMD (Vig & RAC) and CMDs/Discoms
5 AS (Services) - JMD (Vig & RAC) and Director (HRD & Projects)
6 Estate Officer - Director (HRD & Projects) and Director (Finance & Revenue)

ABSTRACT

CE/ELEC 17
CE/CIVIL· 1
CE/TELECOM 1
SEs 21 Excl SEs/DISCOMs
ADDL SECY 1
GM (IR)· 1
GM (CC)/N-C· 1
DS 3
DGM/N-C 1
AS 10
Addl SP/SP 1 Excl DISCOMs
ACS 1
ESTATE OFFICER· 1

Figure 7.1 Organization Chart of APTRANSCO (1/6)

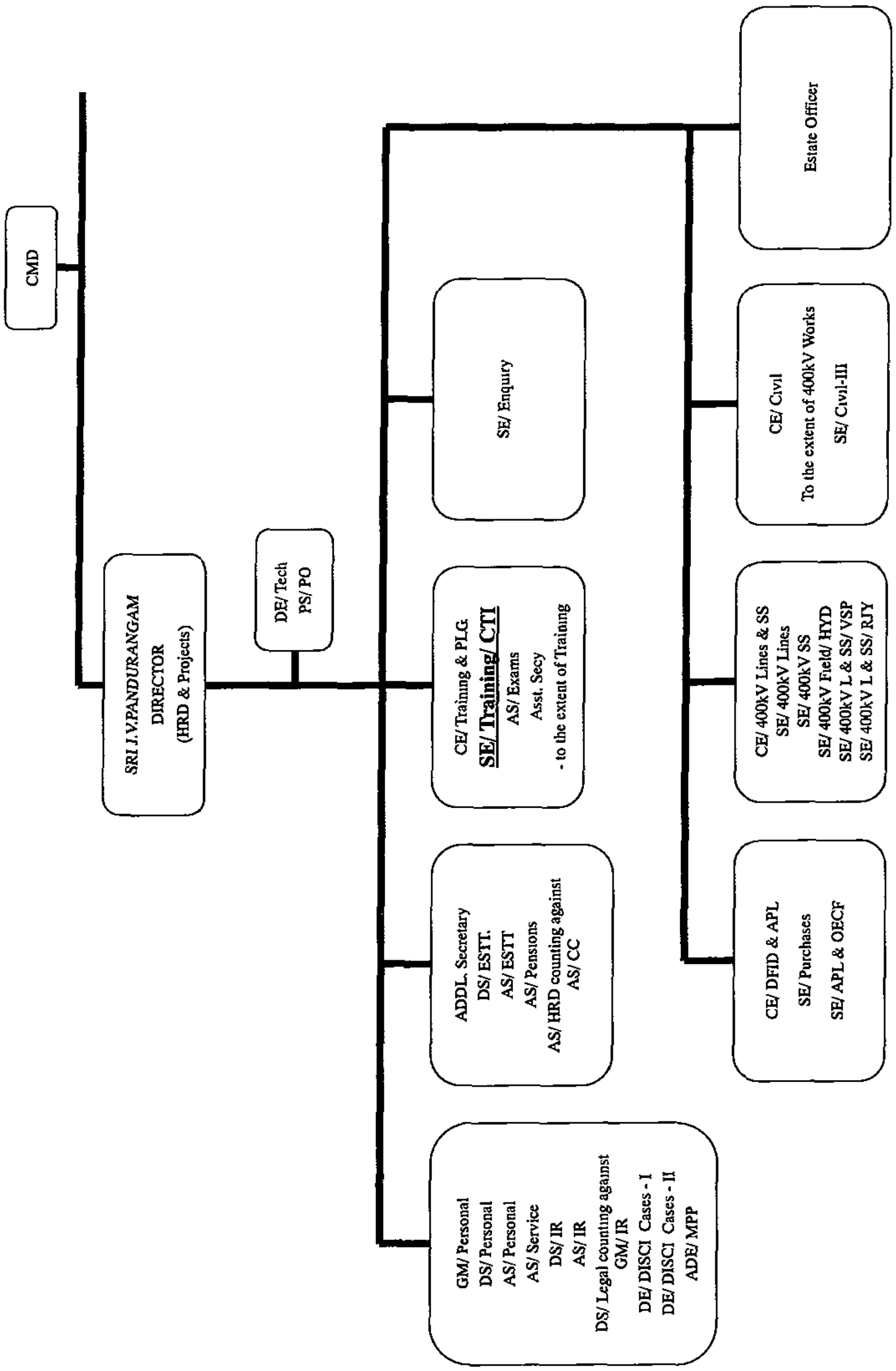


Figure 7.1 Organization Chart of APTRANSCO (2/6)

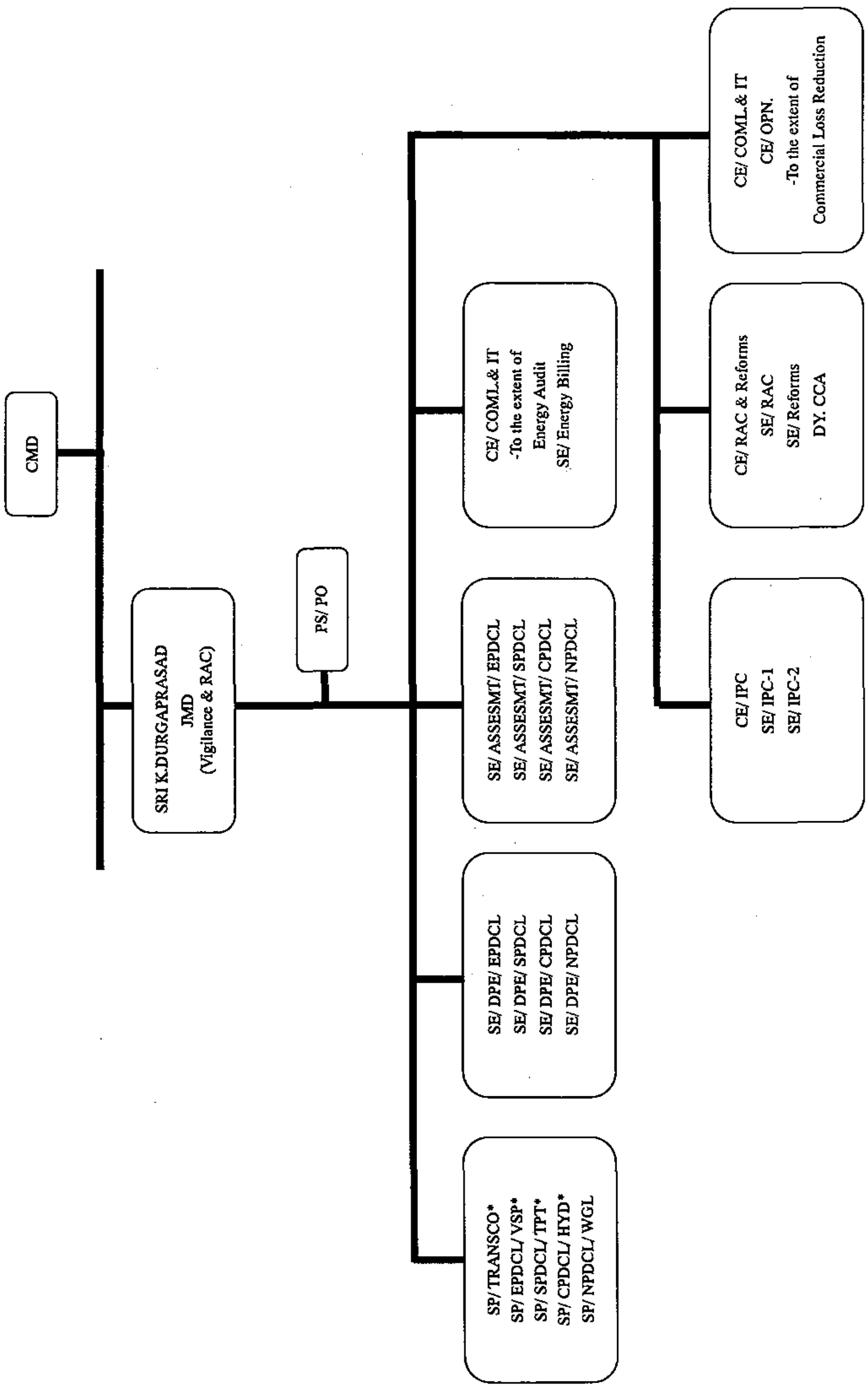


Figure 7.1 Organization Chart of APTRANSCO (3/6)

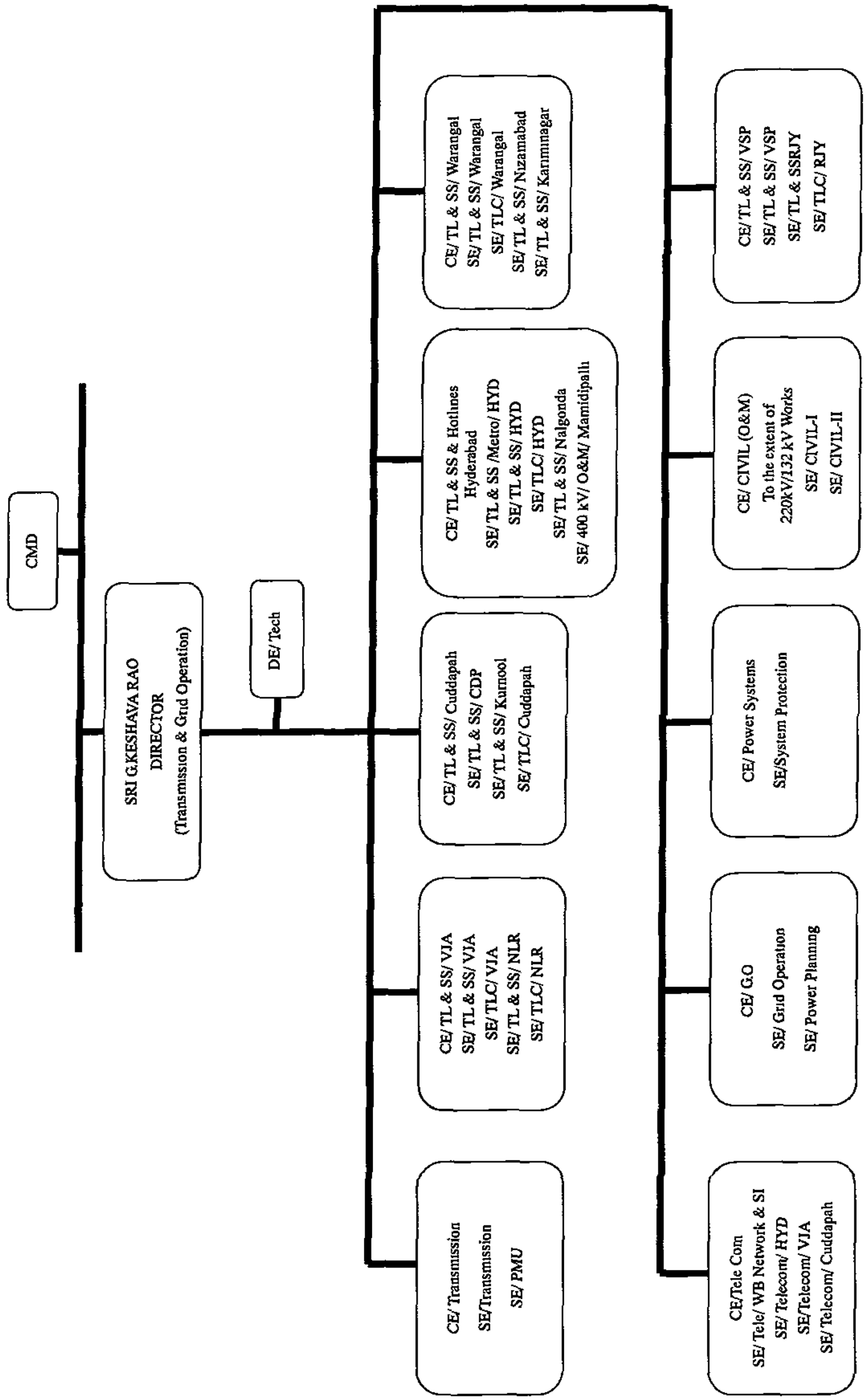


Figure 7.1 Organization Chart of APTRANSCO (4/6)

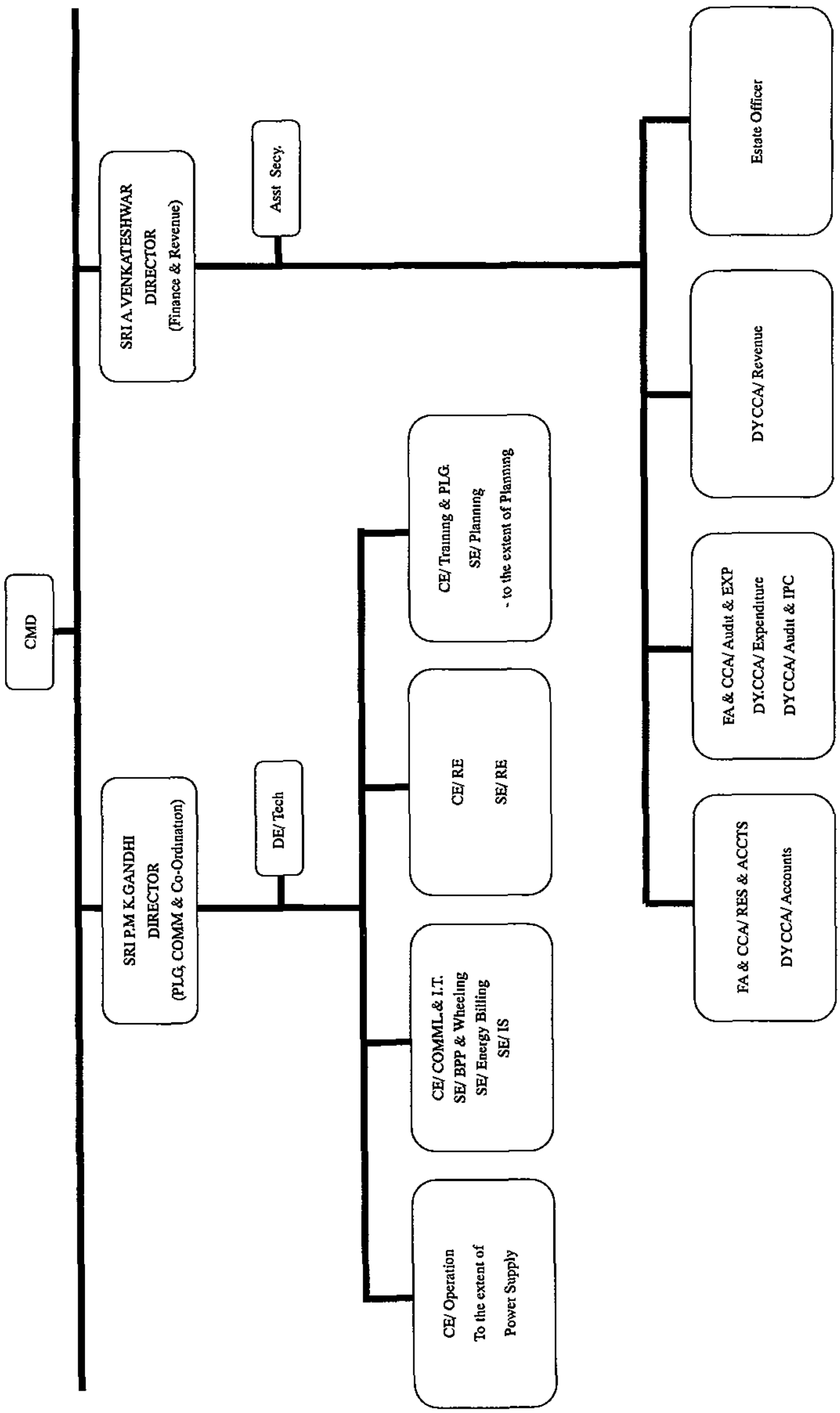


Figure 7.1 Organization Chart of APTRANSCO (5/6)

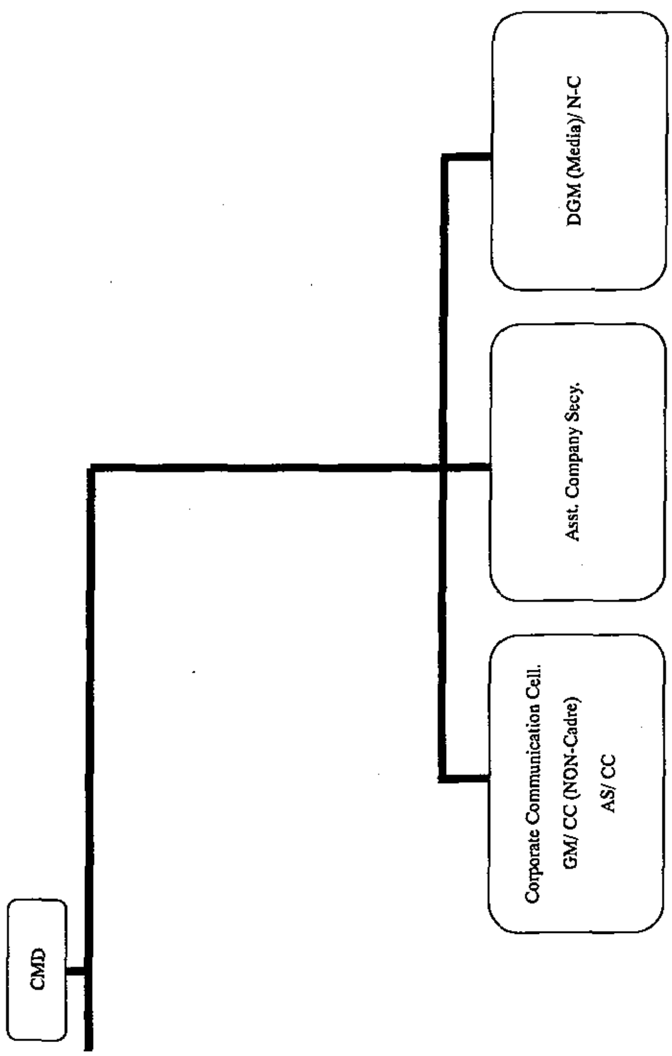


Figure 7.1 Organization Chart of APTRANSCO (6/6)

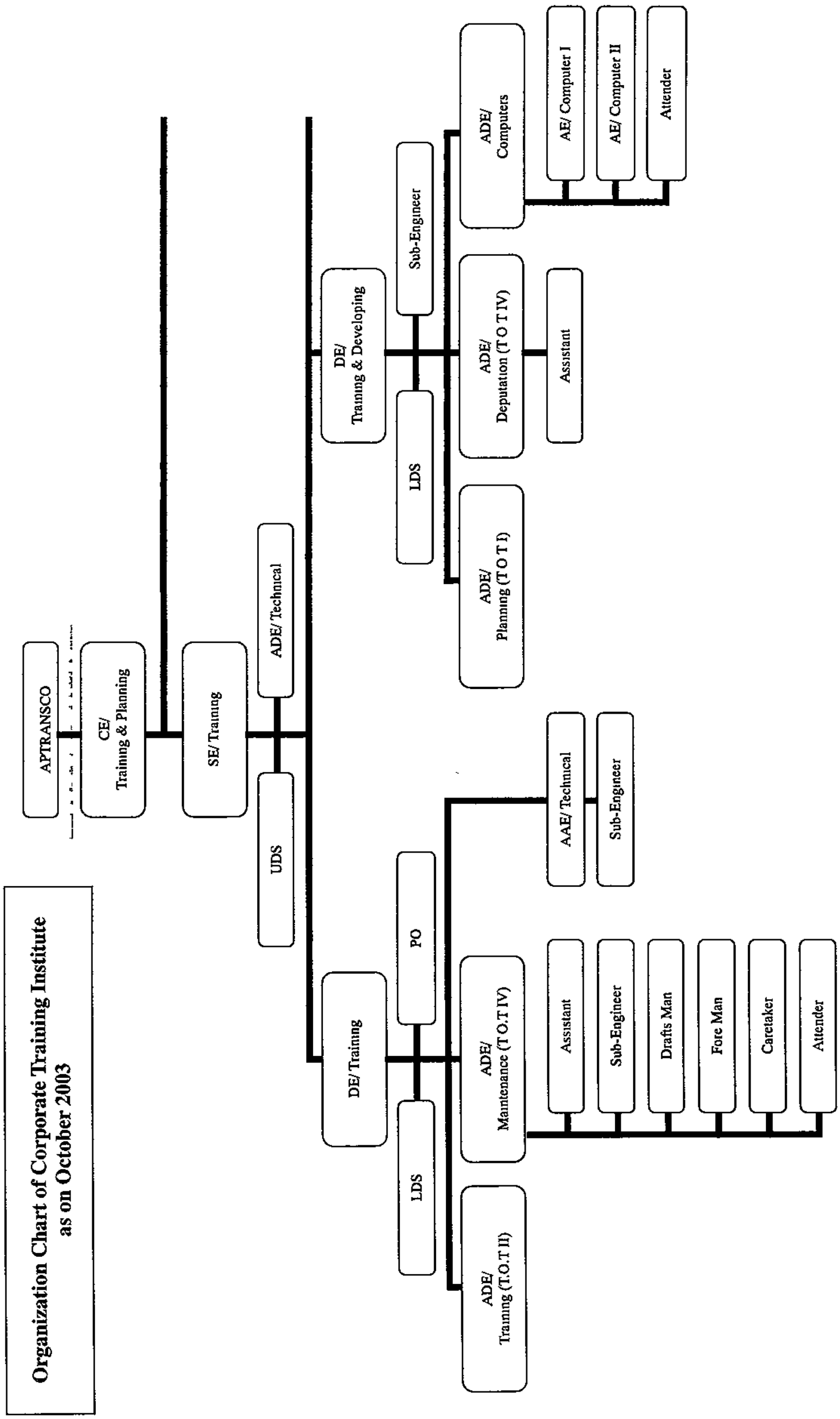


Figure 7.2 Organization Chart of CTI (1/2)

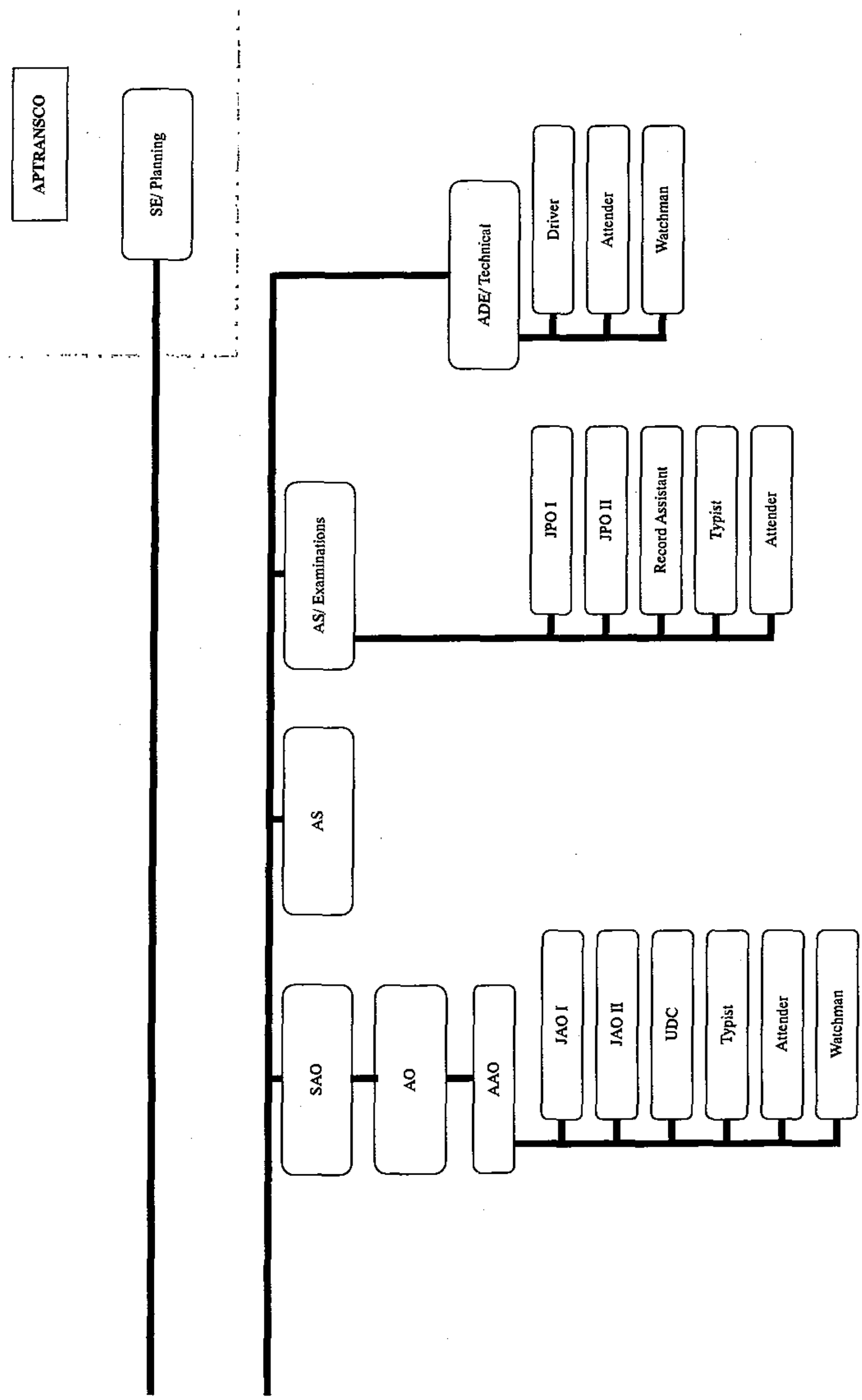


Figure 7.2 Organization Chart of CTI (2/2)

Table 7.1 Specifications of personal computers in the Computer Lab in CTI

No.	Description	Qty
1	Celeron 366 MHz with 32 MB RAM/ 4.3 GB HDD/ 1.44 MB FDD / SIS 6326 with 4 MB VGA Card, VGA Color Monitor/ TVSE Gold Keyboard / Logitech Mouse/ PCI 10/100 NTC Card	10 Nos.
2	Pentium-II 350 MHz 32 MB RAM/ 4.3 GB HDD/ 1.44 MB FDD / ACER VGA Color Monitor/ Acer Keyboard/ MS Mouse	9 Nos.
3	Pentium 133 MHz/ 16MB RAM/ 1.2GB HDD/ 1.44 MB FDD / PCI VGA Card/ Samsung color Monitor/ TVSE Gold Keyboard /Logitech Mouse	2 Nos.
4	486 System PX-4/ 8MB RAM/ 1.2 GB FDD/1.44 MB FDD / NGA Mono Monitor/ PCI VGA Card/ TVSE Gold Keyboard/ Logitech Mouse	1 Nos.

7.2.2 Other Training Facilities

(1) Line Staff Training Center (LSTC)

- LSTC was established to train workers who are sub-engineers, line staff, etc.
- LSTC belongs to CPDCL, and trains workers from CPDCL.
- As training facilities, there is a lecture hall composed of one large and two small hall, an executive lecture room, a dining hall and a hostel block for 30 persons.
- There are training poles and distribution lines in front of the buildings.
- There is a meter testing laboratory, a transformer maintenance facility and a 33/11kV Substation near LSTC, and they are used for practical training.
- The total number of LSTC staff is four persons.
- The organization charts of CPDCL and LSTC are shown in Figure 7.3 and Figure 7.4.

(2) Engineering Staff College of India (ESCI)

- Engineering Staff College of India (ESCI) was established in October 1981 by the premier body of professional engineers of India, The Institution of Engineers (India).
- The primary objectives of ESCI are to impart professional & need based continuing education and training in frontier areas of engineering and management fields, simultaneously providing professional consultancy & technical services to the industry.
- The 70acre sprawling campus of ESCI is about 15 km from the center of Hyderabad city.
- ESCI has its main building and four hostel blocks, which can accommodate up to 100 participants.
- Classrooms are equipped with audio-visual aids to conduct 5 concurrent programs.
- ESCI Information Center has about 6,000 books & reports and 85 periodicals including international journals.
- ESCI Center for Information Technology is providing training and consultancy in information technology.

(3) Central Institute of Rural Electrification (CIRE)

- Central Institute for Rural Electrification (CIRE) was established at Hyderabad in 1979 under the aegis of Rural Electrification Corporation Limited (A Government of India Enterprise) to cater for the training and development needs of engineers and managers of the power and energy sector and other organizations concerned with power and energy.
- The complex of CIRE is over an area of about 17 acres, with administrative, teaching and hostel blocks.
- While the teaching block has 4 classrooms and 16 Syndicate rooms, the hostel block has 38 double-bed occupation rooms with recreation facilities.
- The Institute has a library and is equipped with latest teaching aids such as LCD, OHPs, Slide Projector, Computers, internet and e-mail.

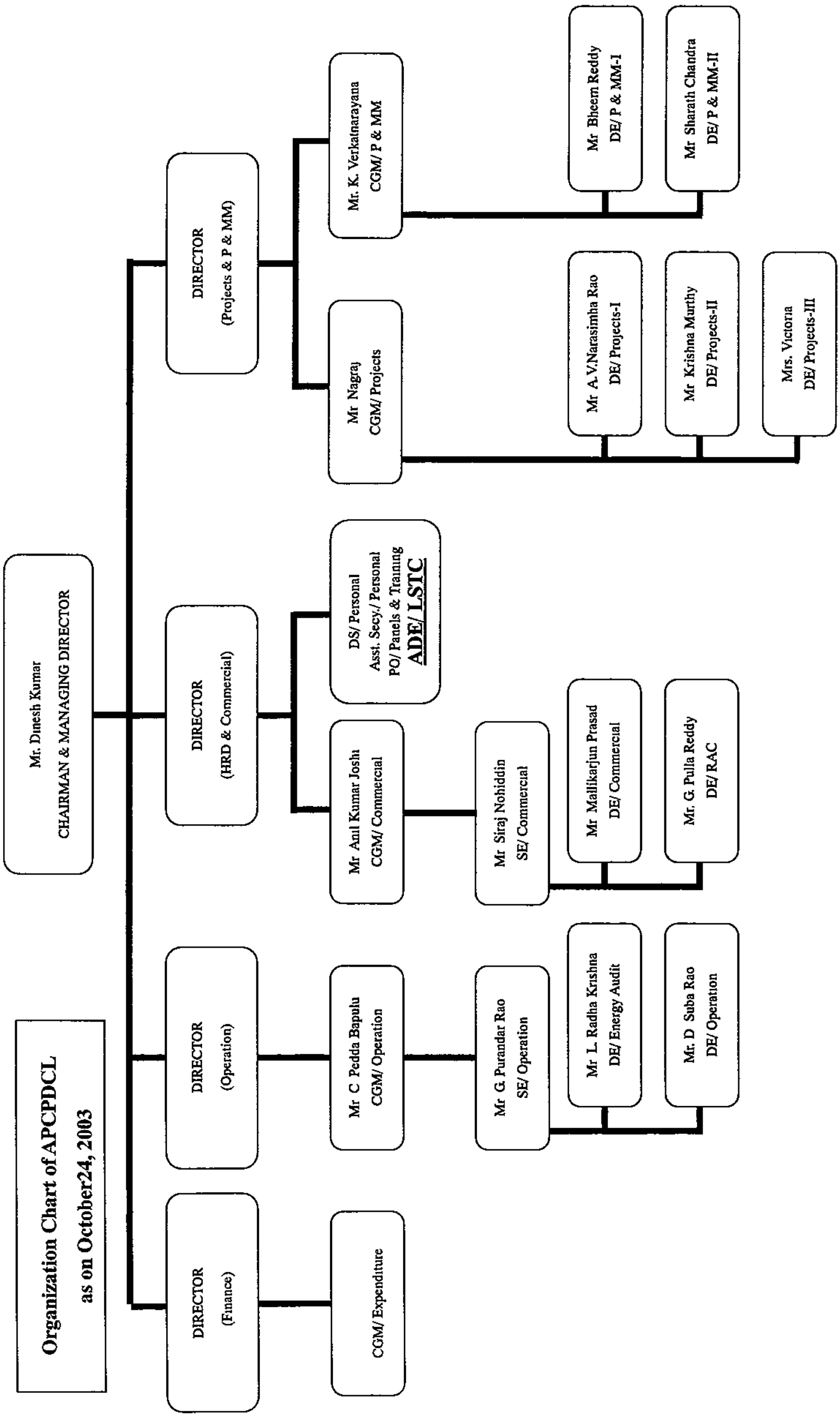


Figure 7.3 Organization Chart of CPDCL (1/4)

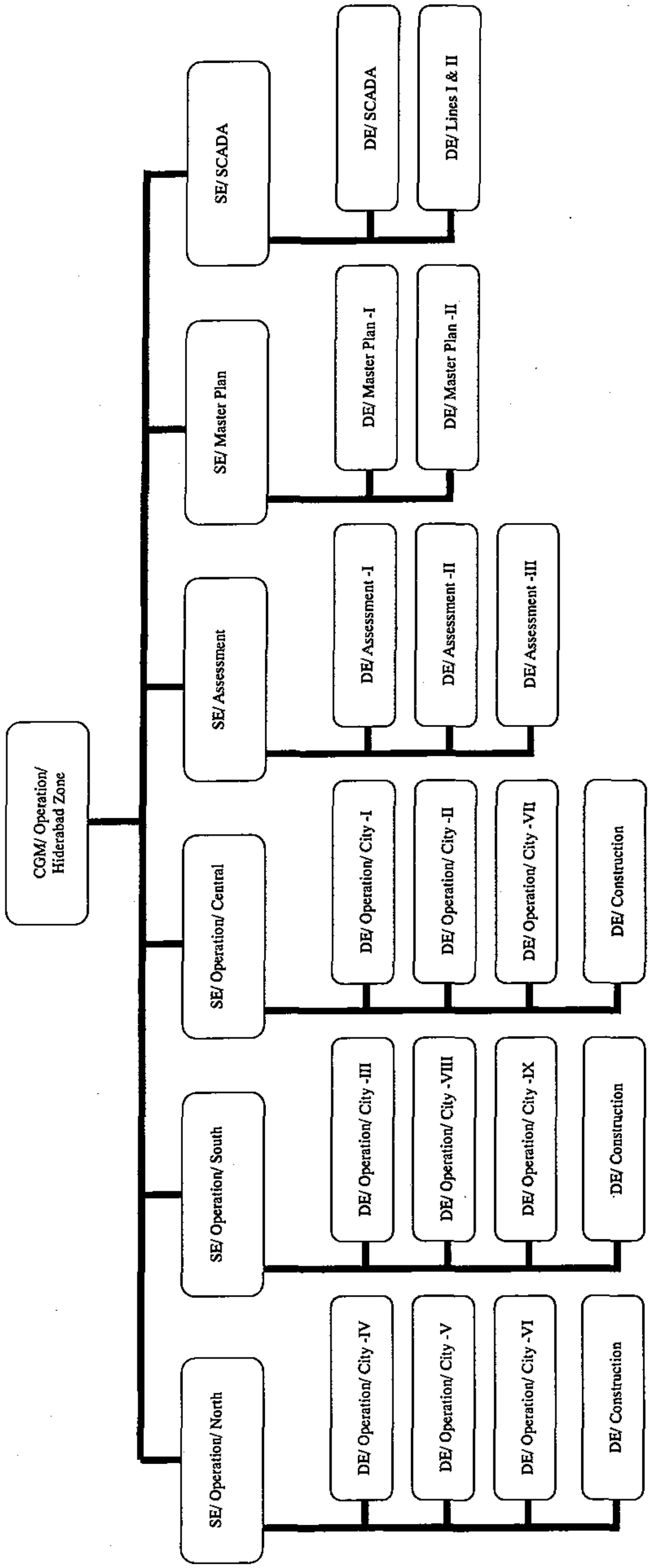


Figure 7.3 Organization Chart of CPDCL (2/4)

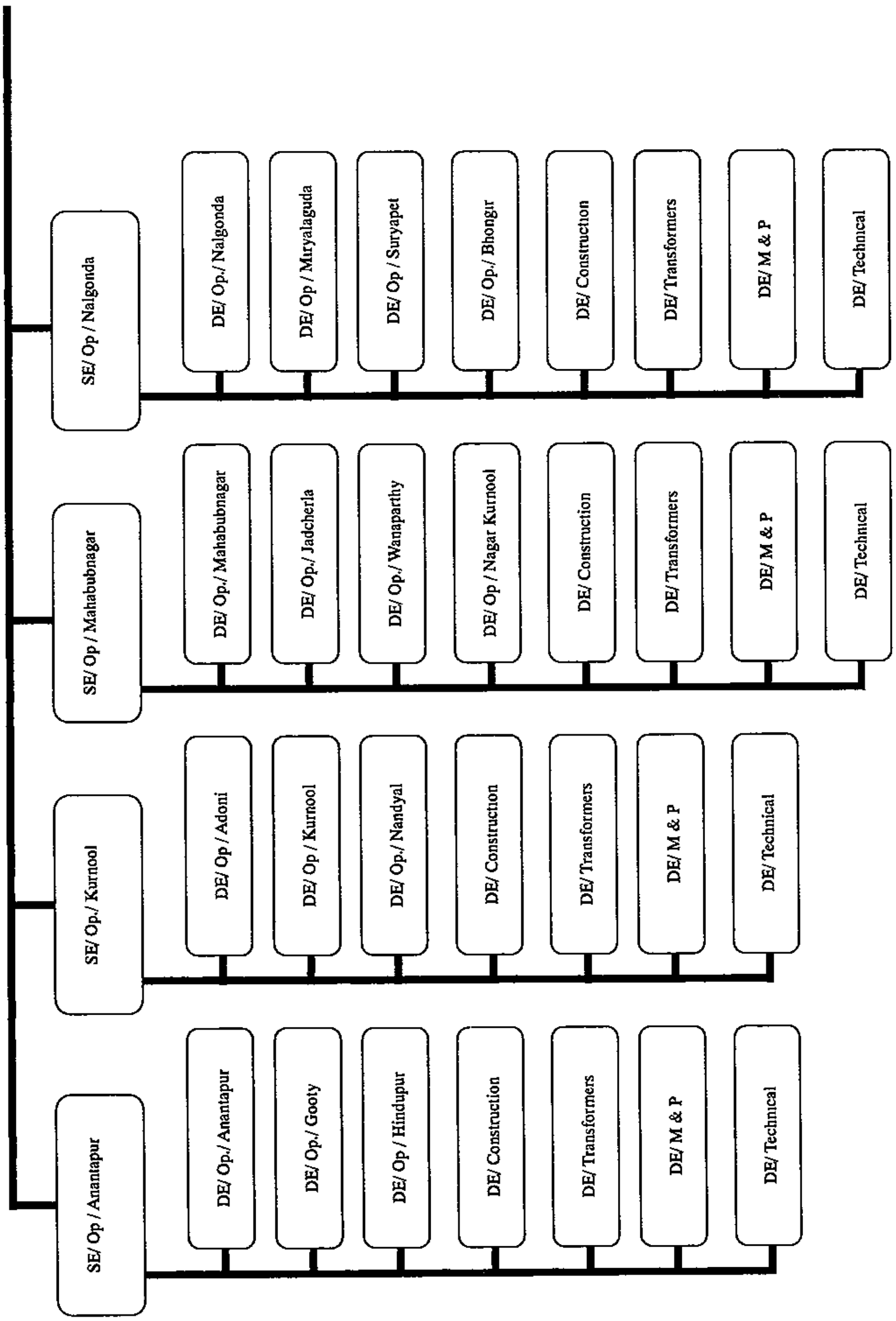


Figure 7.3 Organization Chart of CPDCL (3/4)

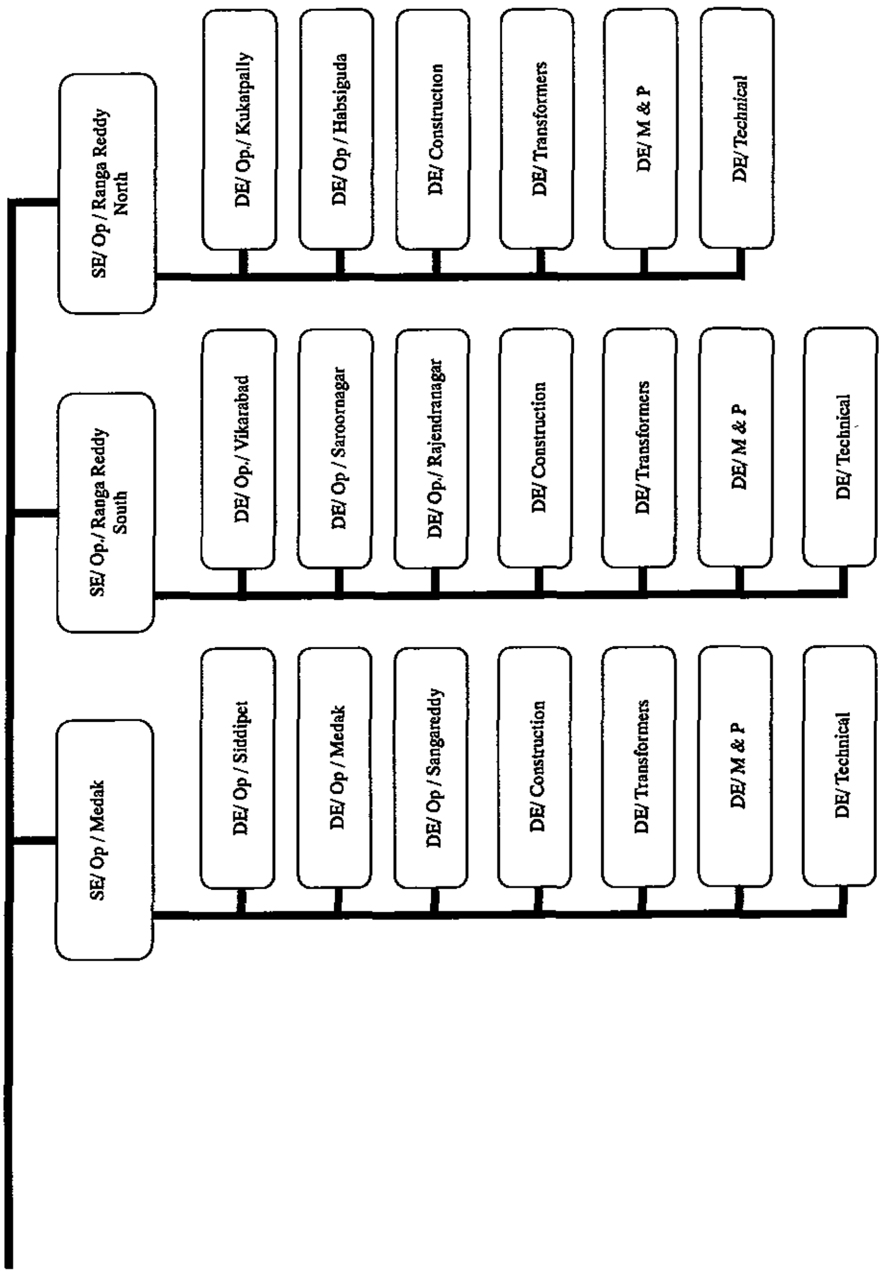


Figure 7.3 Organization Chart of CPDCL (4/4)

Organization Chart of Line Staff Training Center as on October 2003

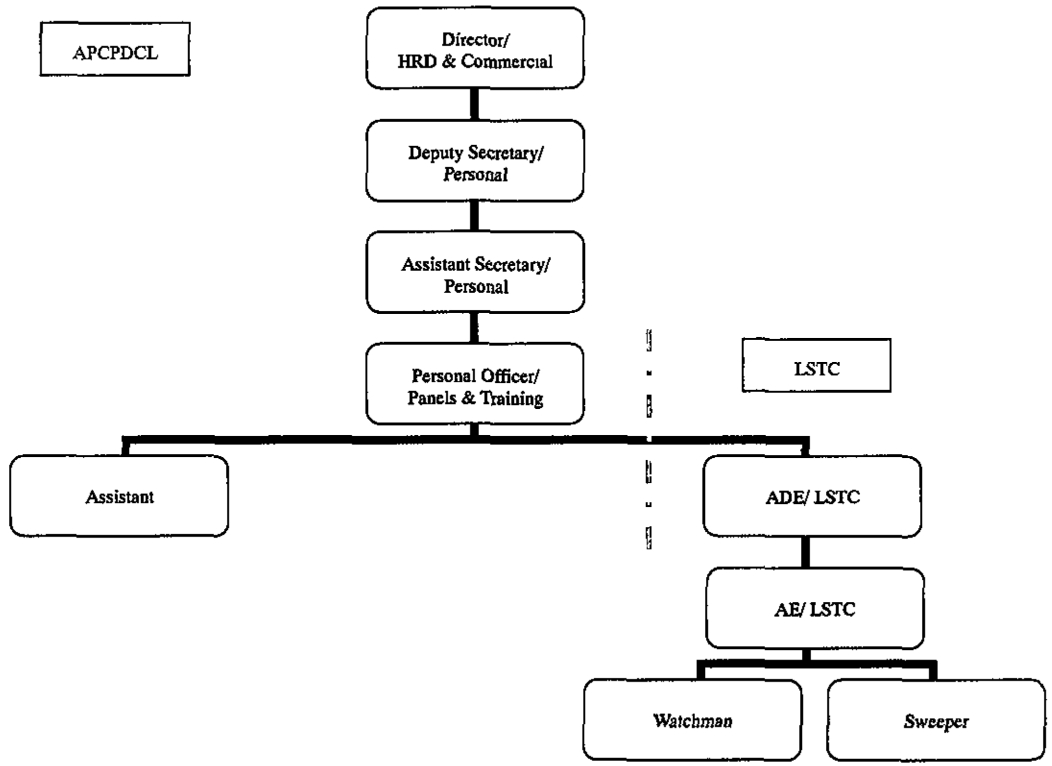


Figure 7.4 Organization Chart of LSTC

7.3 Improvement Plan for Training Facilities

7.3.1 CTI

- More practical training that introduces a training relay panel as a power system simulator, which ties up with LSTC and uses its distribution training poles, etc, will be adopted.
- The application software of "Power Point" and "Video Demonstration" will be adopted because "Power Point" is now applied in computer laboratories only.
- All lecture halls will be equipped with air-conditioning.
- A larger lecture hall equipped an audio visual system will be constructed in addition to the existing lecture halls.
- A prospective drawing of CTI is shown Figure 7.5.

7.3.2 LSTC

- At LSTC, a new training program introducing personal computers will be adopted.

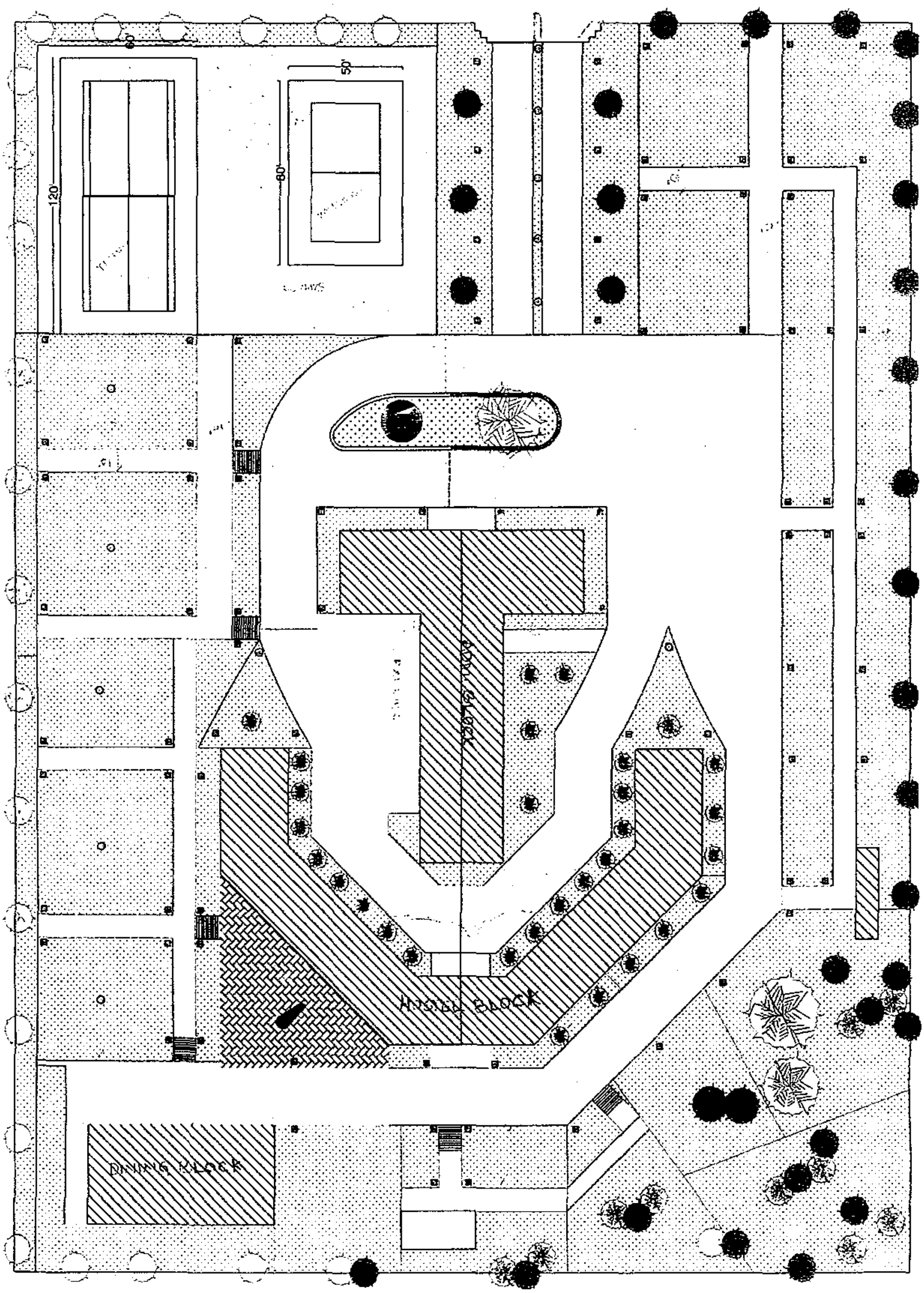


Figure 7.5 Prospective drawing of CTI

7.4 Existing Training Programs

7.4.1 Training Programs of CTI

- CTI and DISCOMs are planning 104 training programs during 2003-2004. The Annual Training Plan for Year 2003-2004, External Training Programs and overall training man-days are shown in Tables 7.2~ 7.5. These Tables are placed at the end of this chapter.
- Lectures are given by trained engineers and officers from APTRANSCO, etc, or by an entrusted faculty from ESCI, etc.
- Since environmental problems have recently been emphasized, a new five-day training program entitled "Environmental & Pollution problems in Transmission Lines & Substations" was conducted last year.
- The training program of CTI is divided into three major groups, which are training programs for engineers, training programs for accounts and administration staff, and practical computer training.
- An induction training, which includes 66 programs for the newly recruited, is executed. This training program takes one month and includes site visits at the end of the training.
- One lecture period is one hour and thirty minutes. As the daily schedule, lectures are from 9:30 to 12:45 in the morning and from 13:45 to 17:00 in the afternoon, including tea breaks and lunch time.
- The basic course, which includes learning the application software of Word, Excel and Power Point, etc, and several advanced courses are conducted in the computer laboratory. The capacity of each course is 20 persons, and the term of each course is six days.

7.4.2 Other Training Programs

(1) Line Staff Training Center (LSTC)

- LSTC is planning 20 training programs during 2003-2004. The training programs include technical matters, for example, "repairing transformer" etc, and customer service matters, such as "electric tariffs," "saving on electricity," etc. The Annual Training Calendar for Year 2003-2004 is shown in Table 7.6. Table 7.6 is placed at the end of this chapter.
- The training term is from a minimum of one day up to a maximum of 15 days.
- Lectures are conducted by trained engineers and officers from APCPDCL, etc.
- The capacity of each course is 30 persons, but the capacity of courses concerned with safety is 80 to 100 persons.
- The opening frequency of the same training program is four to six times per year. It is adjusted to meet demand from CPDCL branches.
- LSTC cooperates with other parties such as the "Federation of Farmers Association" that is conducting a pilot project on farms. LSTC trains not only workers from CPDCL, but also workers from this association because trainees will become line staff, and they will maintain, operate, meter, bill and collect money for 33/11kV sub stations, 11kV feeders and low voltage lines by themselves.
- The total number of trainees for Year 2002-2003 is approximately 2000 persons.
- From November 2003, a course of "Mind Set Training" will be opened to the junior employee of CPDCL.

(2) Engineering Staff College of India (ESCI)

- ESCI has six training division, which are "Power & Energy," "Quality, Productivity &

Environment," "Management & Technology," "Water Resources Development," "Rural & Urban Development," "Civil/ Transportation Engineering" and "Information Technology."

- ESCI is planning 32 training programs during the financial year of 2003-2004. The Calendar of Training Programs April 2003 - March 2004 (Power & Energy Division) is shown in Table 7.7. Table 7.7 is at the end of this chapter.
- Continuing Education Programs are formulated and these are open to serving engineers of public and private sector organizations as well as State and Central Government departments.
- ESCI also organizes & conducts tailor-made in-house programs to meet specific requirement of such organizations.
- ESCI conducts Postgraduate Diploma Courses in Quality Management, Construction Management & Transportation Engineering.
- ESCI has core faculty in all engineering and management disciplines comprising of very senior engineers, eminent scientists and teachers who have rich experience in respective fields, collectively representing several decades of professional experience.
- ESCI derives faculty services, (Visiting and Adjunct Faculty) from a large number of national and international organizations.

(3) Central Institute for Rural Electrification (CIRE)

- CIRE is planning 15 training programs during 2003-2004. The Calendar of Training Programs April 2003 - March 2004 is shown in Table 7.8. Table 7.8 is at the end of this chapter.
- CIRE has organized up to March 2003, 621 training programs and 12,224 officers from State Electricity Boards, Electricity Departments, Rural Electric Co-operatives, Banks, Rural Development Agencies etc. participated in various programs.
- CIRE also organizes Seminars and Workshops in collaboration with other organizations on topical themes.
- Tailor made programs on specialized subjects can be conducted at a place chosen by the sponsoring organization.
- CIRE has set up an Energy Park to develop awareness of soft energy paths i.e. NRSE (New and Renewable Sources Energy) system by demonstrating the technical and economic feasibility of such systems. It has a Solar Photovoltaic Street Lighting System, Solar Photovoltaic Lantern, Solar Water Heating System, Solar Photovoltaic Pumping System and a 4kW Wind Energy System with battery backup and Solar Cooker.