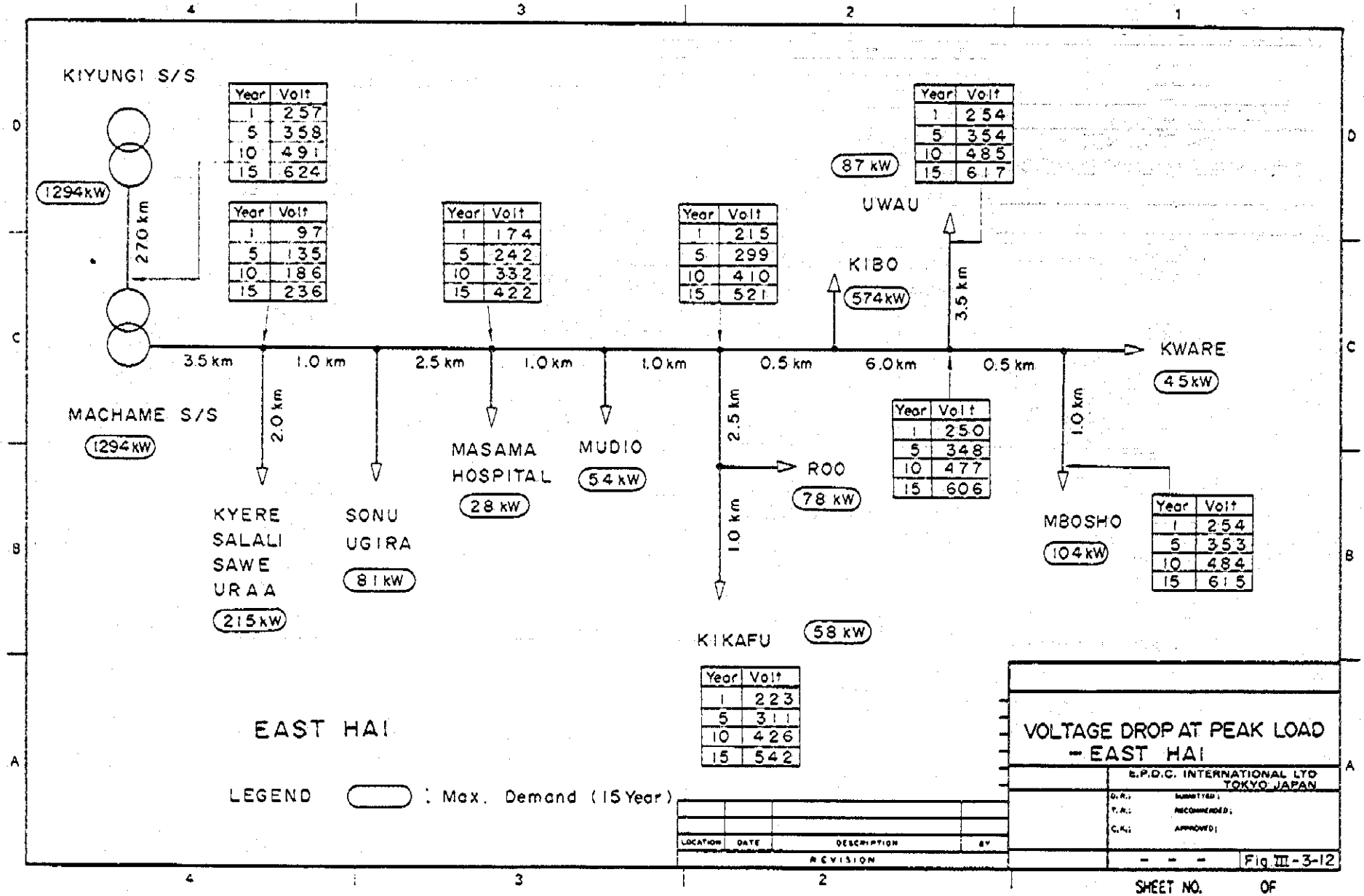
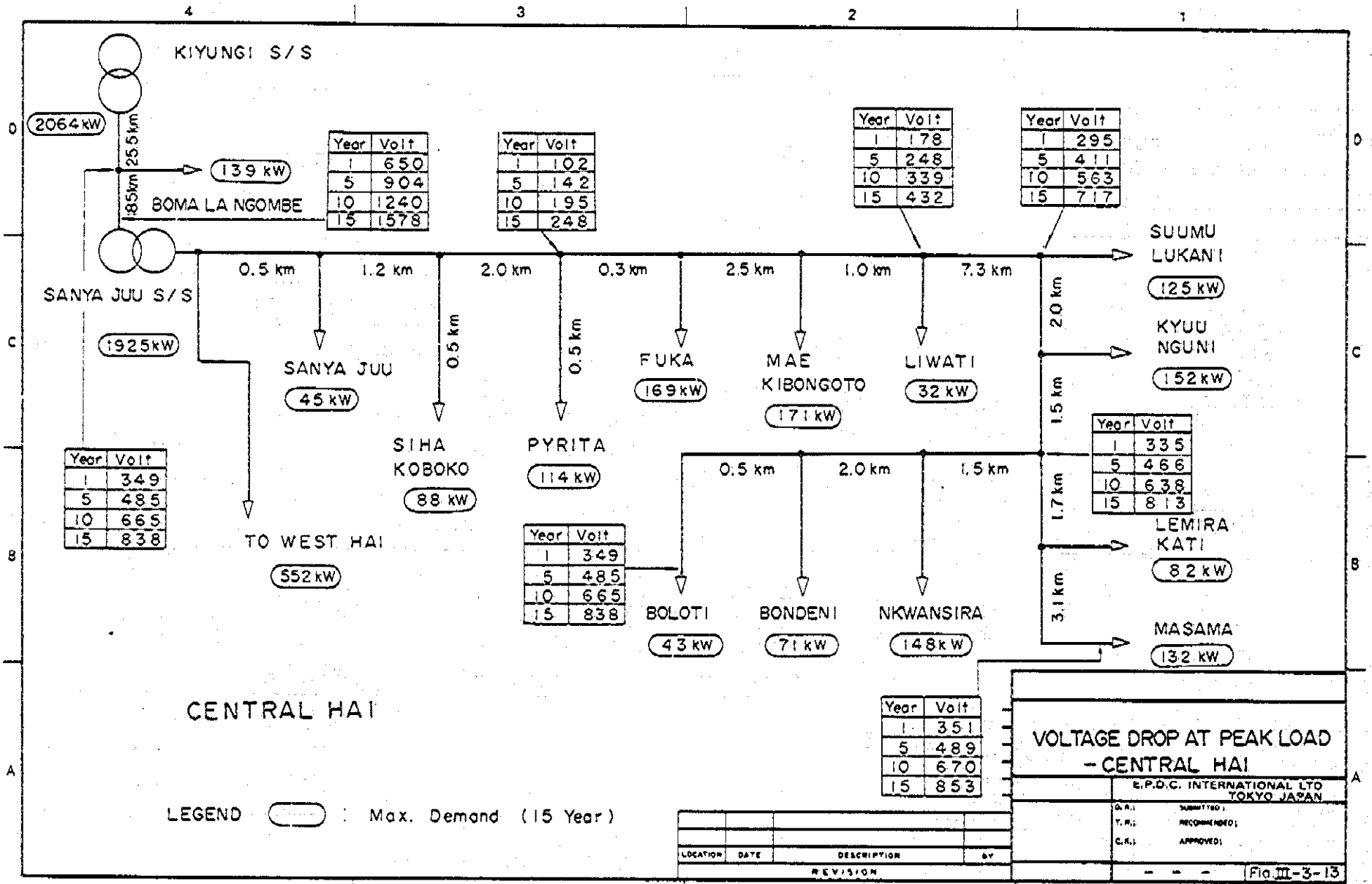
A-6

VOLTAGE DROP OF TRANSMISSION AND DISTRIBUTION LINE AT PEAK LOAD


KIYUNGI S/S
1294kW
270 km
MACHAME S/S
1294 kW
3.5 km
1.0 km
2.5 km
1.0 km
1.0 km
0.5 km
6.0 km
0.5 km
2.0 km
KYERE
SALALI
SAWE
URAA
215kW
SONU
UGIRA
81 kW
MASAMA
HOSPITAL
28 kW
MUDIO
54 kW
2.5 km
ROO
78 kW
10 km
KIKAFU
58 kW
87 kW
UWAU
KIBO
574kW
3.5 km
KWARE
45kW
1.0 km
MBOSHO
104kW
Year Volt
1 257
5 358
10 491
15 624
Year Volt
1 97
5 135
10 186
15 236
Year Volt
1 174
5 242
10 332
15 422
Year Volt
1 215
5 299
10 410
15 521
Year Volt
1 254
5 354
10 485
15 617
Year Volt
1 250
5 348
10 477
15 606
Year Volt
1 254
5 353
10 484
15 615
Year Volt
1 223
5 311
10 426
15 542
EAST HAI
LEGEND : Max. Demand (15 Year)
VOLTAGE DROP AT PEAK LOAD
- EAST HAI
E.P.D.C. INTERNATIONAL LTD
TOKYO JAPAN
LOCATION DATE DESCRIPTION BY
REVISION
Fig III-3-12
SHEET NO. OF



Year	Volt
1	650
5	904
10	1240
15	1578

Year	Volt
1	102
5	142
10	195
15	248

Year	Volt
1	178
5	248
10	339
15	432

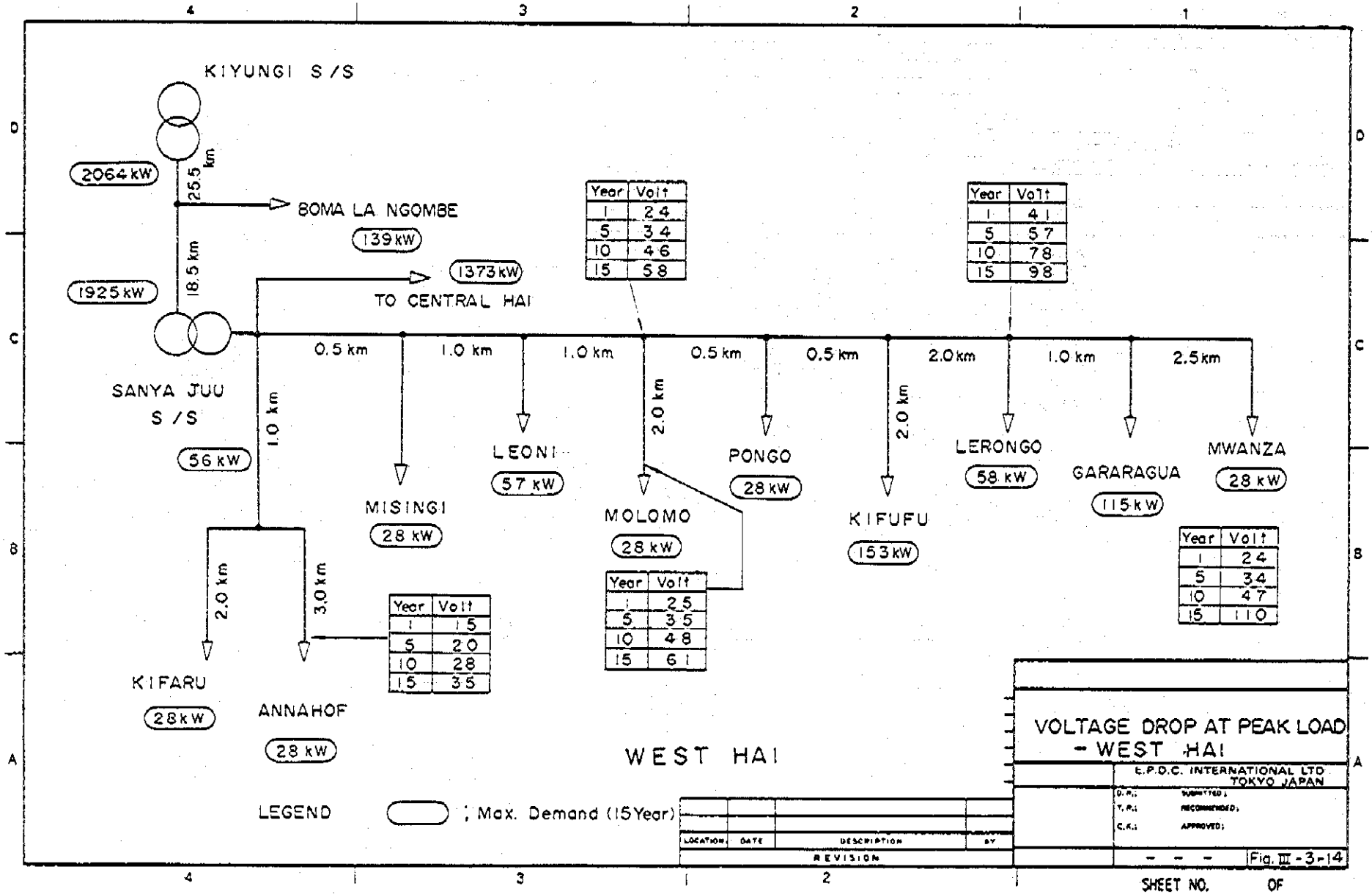
Year	Volt
1	295
5	411
10	563
15	717

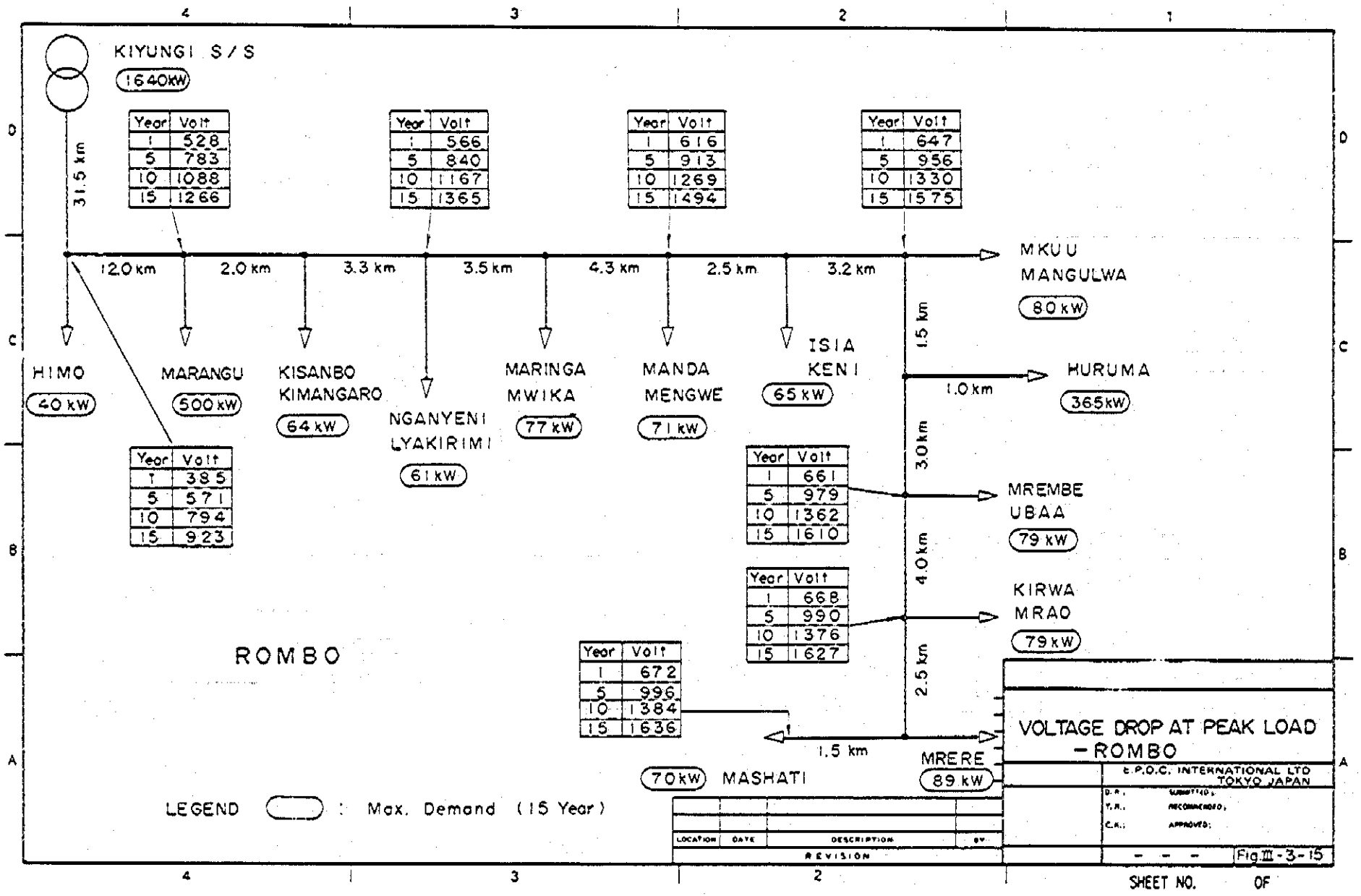
Year	Volt
1	335
5	466
10	638
15	813

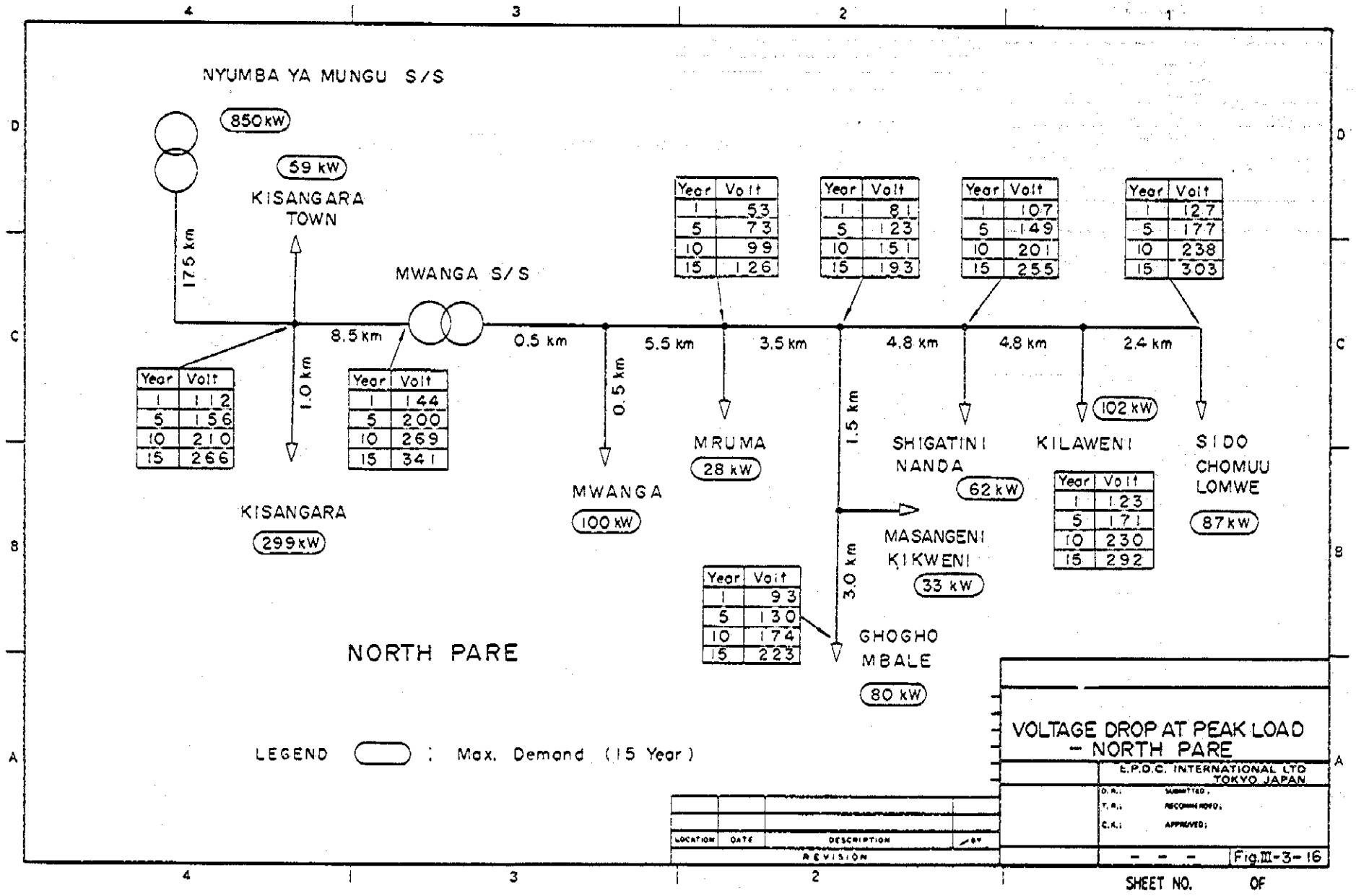
Year	Volt
1	349
5	485
10	665
15	838

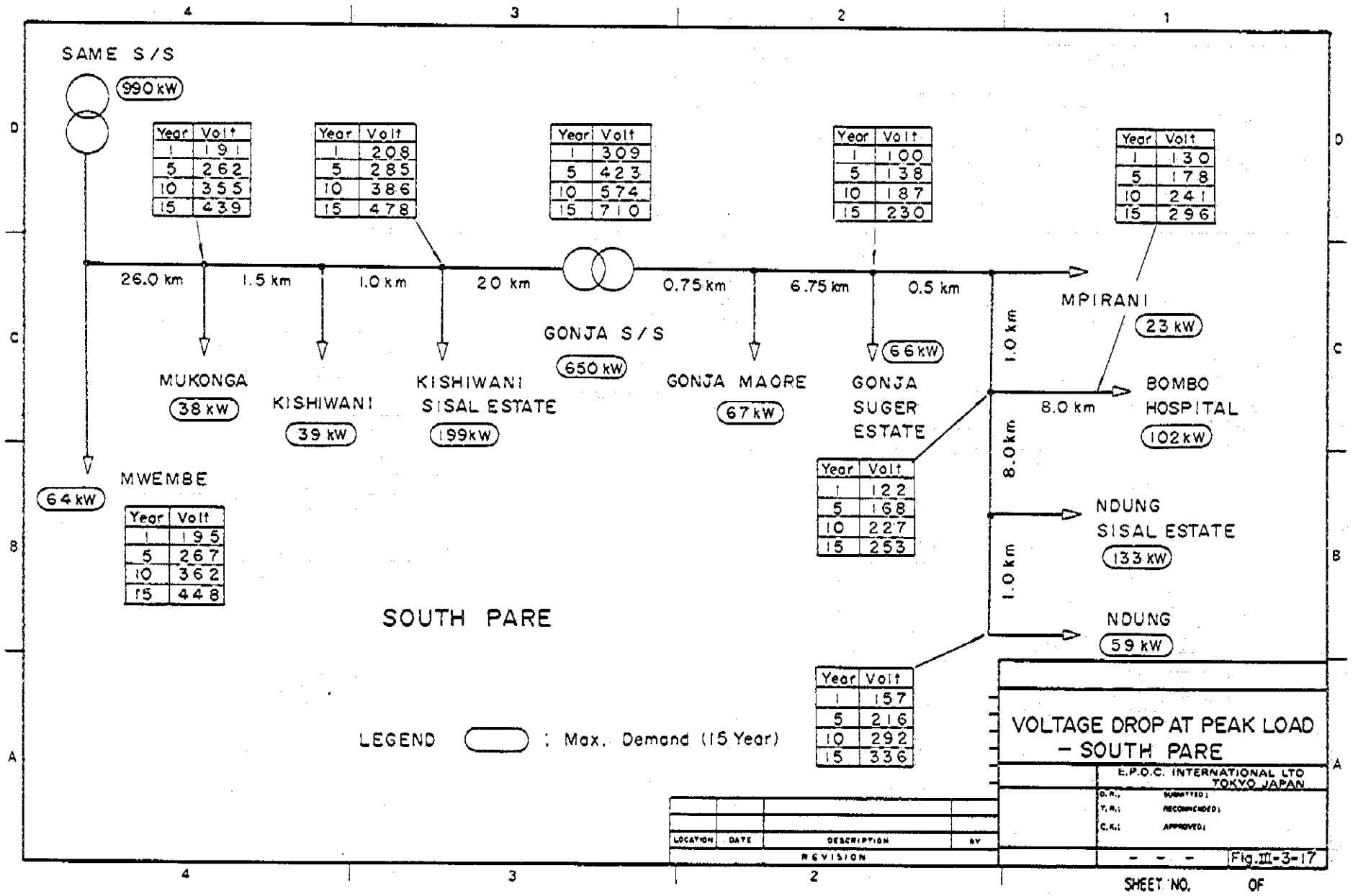
Year	Volt
1	349
5	485
10	665
15	838

Year	Volt
1	351
5	489
10	670
15	853


KIYUNGI S/S
2064 kW
25.5 km
BOMA LA NGOMBE
139 kW
1925 kW
18.5 km
1373 kW
TO CENTRAL HAI
SANYA JUU S/S
56 kW
0.5 km
1.0 km
1.0 km
0.5 km
0.5 km
2.0 km
1.0 km
2.5 km
1.0 km
2.0 km
2.0 km
3.0 km
MISINGI
28 kW
LEONI
57 kW
MOLOMO
28 kW
PONGO
28 kW
KIFUFU
153 kW
LERONGO
58 kW
GARARAGUA
115 kW
MWANZA
28 kW
KIFARU
28 kW
ANNAHOF
28 kW
WEST HAI
LEGEND
; Max. Demand (15 Year)
Year | Volt
1 | 2.4
5 | 3.4
10 | 4.6
15 | 5.8
Year | Volt
1 | 4.1
5 | 5.7
10 | 7.8
15 | 9.8
Year | Volt
1 | 1.5
5 | 2.0
10 | 2.8
15 | 3.5
Year | Volt
1 | 2.5
5 | 3.5
10 | 4.8
15 | 6.1
Year | Volt
1 | 2.4
5 | 3.4
10 | 4.7
15 | 11.0
VOLTAGE DROP AT PEAK LOAD
- WEST HAI
E.P.D.C. INTERNATIONAL LTD
TOKYO JAPAN
LOCATION | DATE | DESCRIPTION | BY
REVISION
Fig. III-3-14
SHEET NO. OF


KIYUNGI S/S
1640kW
31.5 km
12.0 km
2.0 km
3.3 km
3.5 km
4.3 km
2.5 km
3.2 km
1.5 km
1.0 km
3.0 km
4.0 km
2.5 km
1.5 km
HIMO
40 kW
MARANGU
500 kW
KISANBO
KIMANGARO
64 kW
NGANYENI
LYAKIRIMI
61 kW
MARINGA
MWIKA
77 kW
MANDA
MENGWE
71 kW
ISIA
KENI
65 kW
MKUU
MANGULWA
80 kW
HURUMA
365kW
MREMBE
UBAA
79 kW
KIRWA
MRAO
79 kW
MRERE
89 kW
MASHATI
70kW
ROMBO
Year Volt
1 528
5 783
10 1088
15 1266
Year Volt
1 566
5 840
10 1167
15 1365
Year Volt
1 616
5 913
10 1269
15 1494
Year Volt
1 647
5 956
10 1330
15 1575
Year Volt
1 385
5 571
10 794
15 923
Year Volt
1 661
5 979
10 1362
15 1610
Year Volt
1 668
5 990
10 1376
15 1627
Year Volt
1 672
5 996
10 1384
15 1636
LEGEND ( ) : Max. Demand (15 Year)
VOLTAGE DROP AT PEAK LOAD
-ROMBO
E.P.O.C. INTERNATIONAL LTD
TOKYO JAPAN
LOCATION DATE DESCRIPTION BY
REVISION
Fig III-3-15
SHEET NO. OF


NYUMBA YA MUNGU S/S
850kW
59 kW
KISANGARA TOWN
17.5 km
MWANGA S/S
8.5 km
0.5 km
5.5 km
3.5 km
4.8 km
4.8 km
2.4 km
1.0 km
0.5 km
1.5 km
3.0 km
KISANGARA
299kW
MWANGA
100 kW
MRUMA
28 kW
SHIGATINI NANDA
62kW
KILAWENI
102 kW
SIDO CHOMUU LOMWE
87kW
MASANGENI KIKWENI
33 kW
GHOGHO MBALE
80 kW
NORTH PARE
LEGEND : Max. Demand (15 Year)
Year Volt
1 112
5 156
10 210
15 266
Year Volt
1 144
5 200
10 269
15 341
Year Volt
1 53
5 73
10 99
15 126
Year Volt
1 81
5 123
10 151
15 193
Year Volt
1 107
5 149
10 201
15 255
Year Volt
1 127
5 177
10 238
15 303
Year Volt
1 123
5 171
10 230
15 292
Year Volt
1 93
5 130
10 174
15 223
VOLTAGE DROP AT PEAK LOAD
– NORTH PARE
E.P.D.C. INTERNATIONAL LTD
TOKYO JAPAN
LOCATION DATE DESCRIPTION BY
REVISION
Fig.III-3-16
SHEET NO. OF


SAME S/S
990 kW
Year | Volt
1 | 191
5 | 262
10 | 355
15 | 439
Year | Volt
1 | 208
5 | 285
10 | 386
15 | 478
Year | Volt
1 | 309
5 | 423
10 | 574
15 | 710
Year | Volt
1 | 100
5 | 138
10 | 187
15 | 230
Year | Volt
1 | 130
5 | 178
10 | 241
15 | 296
26.0 km
1.5 km
1.0 km
20 km
0.75 km
6.75 km
0.5 km
MUKONGA
38 kW
KISHIWANI
39 kW
KISHIWANI SISAL ESTATE
199kW
GONJA S/S
650 kW
GONJA MAORE
67 kW
GONJA SUGER ESTATE
66 kW
MPIRANI
23 kW
1.0 km
8.0 km
BOMBO HOSPITAL
102kW
8.0km
NDUNG SISAL ESTATE
133 kW
1.0 km
NDUNG
59 kW
MWEMBE
64 kW
Year | Volt
1 | 195
5 | 267
10 | 362
15 | 448
Year | Volt
1 | 122
5 | 168
10 | 227
15 | 253
Year | Volt
1 | 157
5 | 216
10 | 292
15 | 336
SOUTH PARE
LEGEND : Max. Demand (15 Year)
VOLTAGE DROP AT PEAK LOAD
- SOUTH PARE
E.P.O.C. INTERNATIONAL LTD
TOKYO JAPAN
LOCATION | DATE | DESCRIPTION | BY
REVISION
Fig.III-3-17
SHEET NO. OF

A-7

VOLTAGE DROP OF LOW TENSION DISTRIBUTION LINE

A-7 VOLTAGE DROP OF LOW TENSION DISTRIBUTION LINE

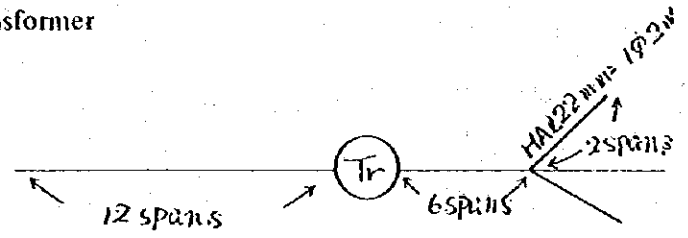
The followings are examples of voltage drop calculations for the average models when distributed by 25 kVA and 50 kVA transformers.

(1) Conditions

a. The voltage drop at the end of line to be below 16 V.
b. The utilization factor of the transformer to be 100%.
c. Assume that the load current is balanced and that the feeder length is half of the total line length.

(2) Calculations

(a) 25 kVA transformer



Conditions

* HA1 22 mm² (1φ 2W) : 1.530Ω/km
* HA1 30 mm² (3φ 4W) : 0.983Ω/km
* Distribution of load points:
  Uniform distribution (50%)
* Power factor: 90%

Calculation

For 3 phase line portion

$$V1 = \sqrt{3} \times 0.983 \times 0.3 \times \frac{12.5}{\sqrt{3} \times 400 \times 0.9} \times 0.5$$

$$= 5V$$

For 1 phase line portion

$$V2 = 2 \times 1.530 \times 0.1 \times \frac{12.5}{\sqrt{3} \times 400 \times 0.9} \times 0.5$$

$$= 0.51V$$

Total voltage drop Vo

$$Vo = \frac{5}{\sqrt{3}} + 0.51$$

$$= 3.4V$$

(For 230 V lighting)

(b) 50 kVA transformer

Conditions

* HA1 30 mm² (1φ 2W) : 0.983Ω/km
* HA1 55 mm² (3φ 4W) : 0.507Ω/km
* Distribution of load points:
  Uniform distribution (50%)
* Power factor: 90%

Calculation

For 3 phase line portion

$$V1 = \sqrt{3} \times 0.507 \times 0.6 \times \frac{25}{\sqrt{3} \times 400 \times 0.9} \times 0.5$$

$$= 11V$$

For 1 phase line portion

$$V2 = 2 \times 0.983 \times 0.2 \times \frac{25}{\sqrt{3} \times 400 \times 0.9} \times 0.5 \times \frac{1}{3} \times 0.5$$

$$= 1.3V$$

Total voltage drop Vo

$$Vo = \frac{11}{\sqrt{3}} + 1.3$$

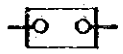
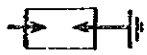
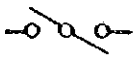
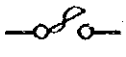
$$= 7.6V$$

(For 230 V lighting)

As shown in (a) and (b), the total voltage drop of a line is below 16 V (4%).

A-8

EXPLANATION OF SYMBOL AND ABBREVIATION

Symbol	Description
	Power transformer delta - star connection
	Power transformer star - star - delta connection
	Single phase transformer
	Oil circuit breaker
	Surge arrester
	Line switch
	Air breaker switch or Oil switch
	Power fuse
	Over current relay
	Over current grounding relay
	Over voltage grounding relay
	Under voltage relay
	Over voltage relay
	Compensating resistor
	Grounding potential transformer
	Current transformer
	Watt - meter

Watt hour meter

Var meter

Voltmeter

Ammeter

Maximum voltmeter

Maximum ammeter

Ammeter change over switch

Voltmeter change over switch or selector switch

Molded-case air circuit breaker

Rectifier

Battery

A-9

CAPACITY AND LOCATION OF POLE MOUNTED TRANSFORMER

Table III-4-1 Capacity & Location of Pole Transformers

For exclusive use transformer for Estate etc, diversity factor of 1.3 is not applicable.

1. Hai

Village & Estate intended for power supply	Load Forecast (kW) T_1	T_2	T_3	T_4	T_5	Total	Calculation (kVA) = Forecase (kW) ÷ 0.9 ÷ 1.3 ÷ 0.6*	Capacity (kVA) of Ttransformer	Location of Transformers
Mwanza Estate			20.0			20.0	22.2	50	Mwanza Estate
Gararagua Estate			80.0			80.0	88.9	100	Gararagua Estate
Lelongo Estate			40.0			40.0	44.4	50	Lelongo Estate
Kifufu Estate				80.0		80.0	88.9	100	Kifufu Estate
Pongo Estate			20.0			20.0	22.2	50	Pongo Estate
Molomo Estate			40.0			40.0	44.4	50	Molomo Estate
Leoni Estate			20.0			20.0	22.2	50	Leoni Estate
Msingi Estate			20.0			20.0	22.2	50	Msingi Estate
Kifaru Estate			20.0			20.0	22.2	50	Kifaru Estate
Annahof Estate			20.0			20.0	22.2	50	Annahof Estate
Sanya Juu	16.6	13.7	–		0.8	31.1	44.3	50	Sanya Juu
Koboko, Nrao, Samaki, Maini	21.5	17.9	22.2		1.0	62.6	89.2	50 25	Koboko Siha
Pyrita Estate				80.0		80.0	88.9	100	Pyrita Estate
Wandri	9.9	35.4	72.8		0.5	118.6	168.9	100 50	Fuka Fuka

Village & Estate intended for power supply	Load Forecast (kW) T_1	T_2	T_3	T_4	T_5	Total	Calculation (kVA) = Forecast (kW) ÷ 0.9 ÷ 1.3 ÷ 0.6*	Capacity (kVA) of Transformer	Location of Transformers
Mae, Kyengia	16.5	16.1	36.5	50.0	0.8	120.0	170.9	50 100	Mae Kibongto Hospital
Liwati	7.3	5.2	9.5		0.4	22.4	31.9	25	Liwati
Koshashi, Lukani	16.4	8.8	60.8		0.8	86.8	123.6	50x2	Suumu Lukani
Kyuu, Losaa, Nguni	31.5	16.1	57.2		1.5	106.3	151.4	50x3	Kyuu, Losaa, Nguni
Bondeni Estate				50.0		50.0	55.6	50	Bondeni Estate
Boloti Estate			30.0			30.0	33.3	50	Boloti Estate
Nkwansira Estate			80.0			80.0	88.9	100	Nkwansira Estate
Nkwansira	5.2	3.7	14.0		0.3	23.2	33.1	25	Nkwansira
Lemira, Kati, Iski	8.9	15.4	32.5		0.4	57.2	81.5	25 50	Kati Lemira
Nroma, Mbweera	17.8	19.7	53.7		0.9	91.8	130.8	50x2	Nroma, Mbweera
Masama Hospital		20.0				20.0	22.2	25	Masama Hospital
Mudio	14.9	7.6	14.4		0.7	37.6	53.6	50	Mudio
Roo	11.2	4.9	38.2		0.5	54.8	78.1	25 50	Roo Roo
Kikafu Estate			40.0			40.0	44.4	50	Kikafu Estate
Kibo Estate				400.0		400.0	444.4	500	Kibo Estate
Uwau Estate			40.0			40.0	44.4	50	Uwau Estate
Kware	7.9	4.4	18.7		0.4	31.4	44.7	50	Kware

Village & Estate intended for power supply	Load Forecast (kW) T_1	T_2	T_3	T_4	T_5	Total	Calculation (kVA) = forecast (kW) ÷ 0.9 ÷ 1.3 ÷ 0.6*	Capacity (kVA) of Transformer	Location of Transformers
Mbosho Estate			50.0			50.0	55.6	50	Mbosho Estate
Mbosho	5.2	3.7	14.0		0.3	23.2	33.1	25	Mbosho
Salali, Sawe, Kyeeri	24.9	16.7	106.3		1.2	149.1	212.4	50×3 25	Salali, Uraa, Sawe, Kyere
Sonu, Ngira	13.3	12.1	31.7		0.6	57.7	82.0	25 50	Sonu Ngira
Nronga, Foo	22.0	14.7	48.2		1.1	86.0	122.5	50×2	Nronga Nkweseko
Boma La Ngombe	6.2	10.5			0.3	17.0	24.2	25	Boma La Ngombe
B. La Ngombe New Town								100	Boma La Ngombe
Mukufi Estate			20.0			20.0	22.2	50	Mukufi Estate
Mokoa			40.0			40.0	44.4	50	Mokoa Estate

Table III-4-2 Capacity & Location of Pole Transformers

2. Rombo

Village & Estate intended for power supply	Load Forecast (KW) T_1	T_2	T_3	T_4	T_5	Total	Calculation (KVA) = Forecast (KW) ÷ 0.9 ÷ 1.3 ÷ 0.6*	Capacity (KVA) of Transformer	Location of Transformers
Komakunai, Kotela, Kiria Kimangara, Mkolowoni	24.8	18.6			1.6	45.0	64 .1	25 50	Kinangaro Kisambo
Msae, Nganyen, Lekura Kinyamrrio, Kondeni	21.3	17.1	3.0		1.3	42.7	60.8	25 50	Lyakirimi Nganyeni
Lole, Mareia, Maringa Minangaro, Mrimbo	29.2	17.7	6.0		1.8	54.7	77.9	50 25	Mwika Maringa
Mengwe Juu, Mamsera Juu Manda Juu, Manda Chini Mengwe Chini	28.3	11.2	9.6		1.2	50.9	72.5	25 50	Manda Mengwe
Kitasha, Mengeni Chini Aleni Chini, Machami Aleni	30.6	10.5	2.0		1.9	45.0	69.1	50 25	Keni Isia
Msho, Simbi-Kati Mahoro, Mkiidi	27.6	27.0	1.0		1.7	57.3	81.6	25 50	Mangulwa Mkuu

Village & Estate intended for power supply	Load Forecast (kW) T_1	T_2	T_3	T_4	T_5	Total	Calculation (kW) = Forecast (kW) ÷ 0.9 ÷ 1.3 ÷ 0.6*	Capacity (kVA) of Transformer	Location of Transformers
Huruma New Twon								100×3	Huruma
Ubaa, Mokala Kolamfua, Ushiri	23.2	12.1	19.1		1.5	55.9	79.6	50 25	Ubaa Mrembe
Keryo, Miao, Kirwa Keni	29.2	12.0	12.8		1.8	55.8	79.5	50 25	Mroa Kirwa
Mrere, Katangara	20.3	16.0	25.9		1.3	63.5	90.5	50×2	Mrere
Kisare, Mahorosha Kilema, Kitowo	23.7	11.9	12.8		1.5	49.9	71.1	25 50	Mashati

Table III-4-3 Capacity & Location of Pole Transformers

3. North Pare

For exclusive use transformer for Estate etc, diversity factor of 1.3 is not applicable.

Village & Estate intended for power supply	Load Forecast (kW) T_1	T_2	T_3	T_4	T_5	Total	Calculation (KVA) = Forecast (kW) ÷ 0.9 ÷ 1.3 ÷ 0.6*	Capacity (kVA) of Transformer	Location of Transformers
Kisangara Sisal Estate				210.0		210.0	233.3	300	Kisangara Sisal Estate
Kisangara	8.1	18.3	14.1		0.5	41.0	58.4	50	Kisangara
Mwanga	5.1	27.4	6.4		0.4	39.3	56.0	50	Mwanga
Mwanga New Town								100	Mwanga New Town
Mruma								25	Mruma
Msangeni, Mamba	6.2	9.8	6.4		0.4	22.8	32.5	25x2	Msangeni Kikweni
Masanbeni, Kisanjuni Raa	14.8	21.7	19.0		0.5	56.0	80.0	25 50	Mbale Ghogho
Shigatini, Ndnda, Kiriche	10.0	27.5	6.4		0.6	44.5	63.4	25x2	Shigatini, Ndnda
Kilaweni, Kighare, Vuanga	8.7	39.4	22.5		0.6	71.2	101.4	25 50	Kilaweni
Kirongaya, Chomuu Lomwe, Mshewa	11.8	8.5	40.0		0.8	61.1	87.0	25x2 50	Chomuu, Lome Sido

Table III-4-4 Capacity & Location of Pole Transformers

For exclusive use transformer for Estate etc, diversity factor of 1.3 is not applicable.

4. South Pore

Village & Estate intended for power supply	Load Forecast (kW) T_1	T_2	T_3	T_4	T_5	Total	Calculation (kVA) = Forecast (kW) ÷ 0.9 ÷ 1.5 ÷ 0.6*	Capacity (kVA) of Transformer	Location of Trnasfromers
Mwembe, Mteke, Mtunguja	12.7	15.9	18.8		0.8	48.2	68.7	25 50	Mwembe
Mukonga, Kisiwani	13.8	24.5	18.8		0.9	58.0	82.6	25 50	Mukonga Kisiwani
Kisiwani Estate				150.0		150.0	166.7	200	Kisiwani Estate
Maore	12.4	23.8	12.8		0.8	49.8	70.9	25 50	Maore Gonja
Gonja Estate				200.0		200.0	222.2	300	Gonja Estate
Mpirani	4.6	11.7			0.3	16.6	23.6	25	Mpirani
Mjema, Bombo, Mvaa	8.7	17.7		50.0	0.6	77.0	109.7	25 100	Mjema Bombo Hospital
Ndungu Estate				100.0		100.0	111.0	200	Ndungu Estate
Ndungu, Misufuni	18.3	24.3			1.2	43.8	62.4	25x2	Ndungu

A-10

SPARE PARTS

List of Spare Parts

	Item	Specification		Q'ty
1.	Line Post Insulator	33 kV	LP-30	50 p.c.s
2.	Pin Type Insulator	11 kV		50 p.c.s
3.	Disc Insulator	254 mm x 146 mm		50 p.c.s
4.	Transformer	11/.4 kV	50 kVA	2 p.c.s
5.	ditto	11/.4 kV	25 kVA	2 p.c.s
6.	ditto	33/.4 kV	50 kVA	2 p.c.s
7.	Primary cut-out switch		14.4 kV	20 p.c.s
8.	ditto		24.5 kV	10 p.c.s
9.	Surge arrester		14 kV	20 p.c.s
10.	ditto		42 kV	10 p.c.s
11.	Watt hour meter			20 p.c.s