A-3　工事費内訳

A－3－1　地区別工事費

A－3－2　工事別工事費

A－3－1　地区別工事費

CONSTRUCTION COST (Hai)

Item	Q'ty	Material		Con-struction	Inland Transport.	Total		
		F.C.	D.C.	D.C.	D.C.	F.C.	D.C.	Total
		10^6 Yen	10^3 T.shs.	10^3 T.shs.	10^3 T.shs.	10^6 Yen	10^3 T.shs.	10^6 Yen
33 kV Transmission Line	30.5 Km	61		552	160	61	712	79
33 kV Distribution Line								
11 kV Distribution Line	95 Km	172	40	1,732	360	172	2,132	225
Pole mounted Transformer	54	44		131	120	44	251	50
L.V. Line	40 Km	40		664	120	40	784	60
Service Line	650	10		98	40	10	138	13
Street Light	50	1		5		1	5	1
Substation		87		506	200	87	706	104
Total		415	40	3,688	1,000	415	4,728	532

Note: A conversion rate of 1T.sh = 25 yen was used for calculation.

CONSTRUCTION COST (Rombo)

Item	Q'ty	Material		Con-struction	Inland Transport.	Total		
		F.C.	D.C.	D.C.	D.C.	F.C.	D.C.	Total
		10^6 Yen	10^3 T.shs.	10^3 T.shs.	10^3 T.shs.	10^6 Yen	10^3 T.shs.	10^6 Yen
33 kV Transmission Line								
33 kV Distribution Line	33 Km	83		660	200	83	860	105
11 kV Distribution Line								
Pole mounted Transformer	23	29		56	80	29	136	33
L.V. Line	25 Km	25		416	80	25	496	37
Service Line	600	9		90	40	9	130	12
Street Light	50	1		5		1	5	1
Substation								
Total		147		1,227	400	147	1,627	187

Note: A conversion rate of 1T.sh = 25 yen was used for calculation.

CONSTRUCTION COST (North Pare)

Item	Q'ty	Material		Con-struction	Inland Transport.	Total		
		F.C.	D.C.	D.C.	D.C.	F.C.	D.C.	Total
		10^6 Yen	10^3 T.shs.	10^3 T.shs.	10^3 T.shs.	10^6 Yen	10^3 T.shs.	10^6 Yen
33 kV Transmission Line	27 Km	52		478	120	52	598	67
33 kV Distribution Line								
11 kV Distribution Line	30 Km	53		537	120	53	657	70
Pole mounted Transformer	16	13		39	40	13	79	15
L.V. Line	15 Km	15		250	40	15	290	22
Service Line	200	3		30		3	30	4
Street Light	30	1		3		1	3	1
Substation		23		198	120	23	318	31
Total		160		1,535	440	160	1,975	210

Note: A conversion rate of 1T.sh = 25 yen was used for calculation.

CONSTRUCTION COST (South Pare)

Item	Q'ty	Material		Con-struction	Inland Transport.	Total		
		F.C.	D.C.	D.C.	D.C.	F.C.	D.C.	Total
		10^6 Yen	10^3 T.shs.	10^3 T.shs.	10^3 T.shs.	10^6 Yen	10^3 T.shs.	10^6 Yen
33 kV Transmission Line	65 Km	127		1,171	320	127	1,491	164
33 kV Distribution Line								
11 kV Distribution Line	27.5 Km	45		472	80	45	552	59
Pole mounted Transformer	14	15		34	40	15	74	17
L.V. Line	10 Km	10		167	40	10	207	15
Service Line	200	3		30		3	30	4
Street Light	30	1		3		1	3	1
Substation		43		309	40	43	349	52
Total		244		2,186	520	244	2,706	312

Note: A conversion rate of 1T.sh = 25 yen was used for calculation.

A－3－2　工事別工事費

33 kV LINE CONSTRUCTION COST

Item	Unit Cost	Hai		Rombo		North Pare		South Pare		Total	
		Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost
MATERIAL (10^6 Yen)											
ACSR 95 mm²/km	0.257	94	24	101	26	83	21	200	51	478	122
Suspention Pole	0.084	220	18	135	12	200	17	460	39	1,015	86
Light Angle Pole	0.092	35	3	70	6	30	3	80	7	215	19
Medium Angle Pole	0.304	17	5	70	21	12	4	25	8	124	38
Sharp Angle Pole	0.253	10	3	35	9	5	1	20	5	70	18
Section Pole	0.264	25	7	25	7	20	5	60	15	130	34
Terminal Pole	0.160	3		5	1	3		5	1	16	2
Air Breaker Switch	0.777	1	1	2	1	1	1	1	1	5	4
Sub total (10^6 Yen)			61		83		52		127		323
CONSTRUCTION (10^3 T.shs)											
Stringing 3φ/Km	11.96	30.5	364.78	33	394.68	27	322.92	65	777.4	155.5	1,859.78
Suspention Pole	0.41	220	90.2	135	55.3	200	82	460	188.6	1,015	416.1
Light Angle Pole	0.56	35	19.6	70	39.2	30	16.8	80	44.8	215	120.4
Medium Angle Pole	1.11	17	18.87	70	77.7	12	13.32	25	27.75	124	137.64
Sharp Angle Pole	1.32	10	13.2	35	46.2	5	6.6	20	26.4	70	92.4
Section Pole	1.67	25	41.75	25	41.75	20	33.4	60	100.2	130	217.1
Terminal Pole	1.11	3	3.33	5	5.55	3	3.33	5	5.55	16	17.76
Sub total			(551.73)		(660.38)		(478.37)		(1,170.7)		(2,861.18)
Total (10^6 Yen)			75		100		64		156		395

Note: This cost is not including inland transportation, spares, contingency, administrative expenses and engineering fee.
A conversion rate of 1 T.sh = 25 Yen was used for calculation.

11 kV LINE CONSTRUCTION COST

Item	Unit Cost	Hai		Rombo		North Pare		South Pare		Total	
		Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost
MATERIAL (10^6 Yen)											
ACSR 95 mm^2/km	0.257	292	75			92	23	85	22	469	120
Suspention Pole	0.055	380	21			120	7	170	9	670	37
Light Angle Pole	0.064	190	12			75	5	45	3	310	20
Medium Angle Pole	0.153	165	25			50	7	30	5	245	37
Sharp Angle Pole	0.179	140	25			40	7	15	3	195	35
Section Pole	0.189	45	9			10	2	15	3	70	14
Terminal Pole	0.133	30	4			5	1	5	1	40	6
Oil Switch	0.134	11	1			3		2		16	1
Sub total (10^6 Yen)			172				52		46		270
CONSTRUCTION (10^3 T.shs)											
Stringing 3ϕ/Km	11.61	95	1,103.0			30	348.3	27.5	319.2	152.5	1,770.5
Suspention Pole	0.35	380	133.0			120	42.0	170	59.5	670	234.5
Light Angle Pole	0.46	190	87.4			75	34.5	45	20.7	310	142.6
Medium Angle Pole	0.96	165	158.4			50	48	30	28.8	245	235.2
Sharp Angle Pole	1.11	140	155.4			40	44.4	15	16.7	195	216.5
Section Pole	1.47	45	66.2			10	14.7	15	22.0	70	102.9
Terminal Pole	0.96	30	28.8			5	4.8	5	4.8	40	38.4
Sub total (10^3 T.shs)			(1,732.2)				(536.7)		(471.7)		(2,740.6)
Total (10^6 Yen)			215				66		58		339

Note: This cost is not including inland transportation, spares, contingency, administrative expenses and engineering fee.
A conversion rate of 1 T.sh = 25 Yen was used for calculation.

POLE MOUNTED TRANSFORMER CONSTRUCTION COST

Item		Unit Cost	Hai		Rombo		North Pare		South Pare		Total	
			Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost
MATERIAL (10^6 Yen)												
33 KV Transformer	25 kVA	1.057	1	1	9	10			2	2	12	13
	50	1.338	2	3	11	14	1	1	2	3	16	21
	100	1.662	1	2	3	5					4	7
	200	2.355							1	2	1	2
	300	2.888					1	3			1	3
11 KV Transformer	25 kVA	0.548	9	5			9	5	5	3	23	13
	50	0.713	34	24			4	3	1	1	39	28
	100	0.968	6	6			1	1	1	1	8	8
	200	1.390							1	1	1	1
	300	1.801							1	2	1	2
	500	2.540	1	3							1	3
Sub Total (10^6 Yen)				44		29		13		15		101
CONSTRUCTION (10^3 T.shs)		2.43	54	131.22	23	55.89	16	38.88	14	34.02	107	260.01
Total (10^6 Yen)				47		31		14		16		108

Note: This cost is not including inland transportation, spares, contingency, administrative expenses and engineering fee.
A conversion rate of 1 T.sh = 25 yen was used for calculation.

L.V. LINE CONSTRUCTION COST

Item	Unit Cost	Hai		Rombo		North Pare		South Pare		Total	
		Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost
MATERIAL (10^6 Yen)											
HAl 55 mm^2/Km	0.133	60	8	37.5	5	22.5	3	15	2	135	18
HAl 30 mm^2/Km	0.076	40	3	25	2	15	1	10	1	90	7
HAl 22 mm^2/Km	0.060	20	1	12.5	1	7.5	1	5		45	3
Suspention Pole	0.034	375	13	235	8	140	5	90	3	840	29
Angle Pole (1°~30°)	0.040	70	3	40	1	25	1	20	1	155	6
Angle Pole (Above 30°)	0.048	50	2	35	2	25	1	15	1	125	6
Terminal Pole	0.038	105	4	65	3	35	1	25	1	230	9
Tee-off	0.009	135	1	85	1	50		35		305	2
Others	0.021	200	4	125	3	75	2	50	1	405	10
Sub Total (10^6 Yen)			39		26		15		10		90
CONSTRUCTION (10^3 T.shs)											
Stringing	10.79	40	431.6	25	269.8	15	161.8	10	107.9	90	971.1
Suspention Pole	0.30	375	112.5	235	70.5	140	42.0	90	27	840	252.0
Angle Pole (1°~30°)	0.43	70	30.1	40	17.2	25	10.8	20	8.6	155	66.7
Angle Pole (Above 30°)	0.55	50	27.5	35	19.25	25	13.75	15	8.25	125	68.75
Terminal Pole	0.43	105	45.2	65	28.0	35	15.0	25	10.7	230	98.9
Tee-off	0.13	135	17.6	85	11.1	50	6.5	35	4.5	305	39.7
Sub Total (10^3 T.shs)			(664.5)		(415.85)		(249.85)		(166.95)		(1,497.15)
Total (10^6 Yen)			56		36		21		14		127

Note: This cost is not including inland transportation, spares, contingency, administrative expenses and engineering fee.
A conversion rate of 1 T.sh = 25 yen was used for calculation.

SERVICE LINE CONSTRUCTION COST

Item	Unit Cost	Hai		Rombo		North Pare		South Pare		Total	
		Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost
MATERIAL (10^6 Yen)	0.016	650	10	600	9	200	3	200	3	1,650	25
CONSTRUCTION (10^3 T.shs)	0.15	650	98	600	90	200	30	200	30	1,650	248
TOTAL (10^6 Yen)			12		11		4		4		31

STREET LIGHT CONSTRUCTION COST

Item	Unit Cost	Hai		Rombo		North Pare		South Pare		Total	
		Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost
MATERIAL (10^6 Yen)	0.026	50	1	50	1	30	1	30	1	160	4
CONSTRUCTION (10^3 T.shs)		50	5	50	5	30	3	30	3	160	16
TOTAL (10^6 Yen)			1		1		1		1		4

Note: This cost is not including inland transportation, spares, contingency, administrative expenses and engineering fee.
A conversion rate of 1 T.sh = 25 yen was used for calculation.

SUBSTATION CONSTRUCTION COST

Item	Sanya Juu S.S 2,500 kVA	Machame S.S 2,500 kVA	Nym S.S 1,000 kVA	Mwanga S.S 500 kVA	Gonja S.S 1,000 kVA	Total
MATERIAL (10^3 Yen)						
33 kV Equipments	5,970	5,970	5,970	4,900	4,900	27,710
Main Transformers	17,370	17,370	5,500	4,350	5,500	50,090
11 kV Equipments	12,480	12,480	7,060	5,750	5,750	43,520
Cable & Others	4,350	4,350	3,250	4,560	4,560	21,070
Spare & Superintendent	3,000	3,000	1,600	1,500	1,510	10,610
Sub Total (10^3 Yen)	(43,170)	(43,170)	(23,380)	(21,060)	(22,220)	(153,000)
CONSTRUCTION (10^3 T.shs)						
Electrical Construction	180	180	148	111	113	732
Civil Workes	73	73	50	41	44	281
Sub Total (10^3 T.shs)	(253)	(253)	(198)	(152)	(157)	(1,013)
Total (10^3 Yen)	49,495	49,495	28,330	24,860	26,145	178,325

Note: A conversion rate of 1 T.sh = 25 yen was used for calculation.

A-4 Calculation Sheets

A－4－1　木柱の強度計算
A－4－2　支持物基礎の安全率
A－4－3　支線の強度
A－4－4　鉄金及びアームタイの強度
A－4－5　弛度計算

A－4－1　木柱の強度計算

(1)　単　　柱

(a)　支線のない場合

$$\frac{P}{F} \geqq 10K \frac{40DoH^2 - 24H^3 + S(\Sigma 10dh)}{Do^3}$$

P　：　破壊強度（560 kg / cm²）

F　：　安全率（4）

K　：　風圧による係数（0.5）

S　：　径間（100 m）

d　：　電線その他の架渉線の外径（13.5 mm）

h　：　電線その他の架渉線の地表上の高さ（9.1 m）

H　：　木柱の地表上の高さ（9.2 m）

Do：　木柱の地表面における直径（27.3 cm）

$$Do = D + 0.9H$$

D：木柱の末口（19 cm）

$$\frac{560}{4} > 10 \times 0.5 \times \frac{20 \times 27.3 \times 9.2^2 - 12 \times 9.2^3 + 0.5 \times 100 \times 10 \times 13.5 \times 9.1 \times 3}{27.3^3}$$

140 ＞ 109 ..... OK

(b)　支線のある場合

$$\frac{P}{F} \geqq 10K \frac{20DoH^2 - 12H^3 + 0.5S(\Sigma 10dh)}{Do^3}$$

$$\frac{560}{4} > 10 \times 0.5 \times \frac{20 \times 27.3 \times 9.2^2 - 12 \times 9.2^3 + 0.5 \times 100 \times 10 \times 13.5 \times 9.1 \times 3}{27.3^3}$$

140 ＞ 54.4 ..... OK

(2)　H　　柱

(a)　支線のない場合

$$\frac{P}{F} \geqq 10K \frac{40DoH^2 - 24H^3 + 0.5S(\Sigma 10dh)}{Do^3}$$

$$\frac{560}{4} > 10 \times 0.5 \times \frac{40 \times 27.3 \times 9.2^2 - 24 \times 9.2^3 + 0.5 \times 100 \times 10 \times 13.5 \times 9.1 \times 3}{27.3^3}$$

140 ＞ 63.4 ..... OK

(b) 支線のある場合

$$\frac{P}{F} \geqq 10K \frac{20DoH^2 - 12H^3 + 0.25S(\Sigma 10dh)}{Do^3}$$

$$\frac{560}{4} > 10 \times 0.5 \times \frac{20 \times 27.3 \times 9.2^2 - 12 \times 9.2^3 + 0.25 \times 100 \times 10 \times 13.5 \times 9.1 \times 3}{27.3^3}$$

$$140 > 31.7 \cdots\cdots\cdots\cdots\cdots\cdots \text{OK}$$

A－4－2　支持物基礎の安全率

$$F \leqq \frac{0.3K(DoQt^4 + AJ)}{P(H + t'o)^2}$$

F　：安全率

D_0：支持物の地際の直径（0.273 m）

t　：支持物の根入の深さ（1.8 m）

H　：集中荷重点の地表上の高さ（9.1 m）

P　：支持物に加わる荷重（kg）

$$P = Pp + Pw$$

$$Pp = \frac{1}{6} Wp(2D_1 + D_0)H$$

W_p：支持物に加わる単位面積あたりの風圧荷重（kg / m²）

D_1：支持物の末口径（0.19 m）

$$Pp = \frac{50}{6} \times (2 \times 0.19 + 0.273) \times 9.1 = 49.5 \text{ (kg)}$$

P_p：支持物に加わる風圧荷重（kg）

P_w：電線に加わる風圧荷重（kg）

$$Pw = 100 \times 0.0135 \times 3 \times 50 = 202.5 \text{ (kg)}$$

$$P = 49.5 + 202.5 = 252 \text{ (kg)}$$

t'o：地表面から支持物の回転中心までの深さ

$$t'o = \frac{2}{3}\left(\frac{t^2 + 3ntc^2}{t + 2ntc}\right) \text{ (m)}$$

$$n = \frac{A}{A_1}$$

A_1：木柱基礎部の面積（m²）

A：根かせの面積（m²）

$$A = (L - Do)d$$

L：根かせの深さ（m）

d：根かせの幅（m）

$$\therefore A = (1.5 - 0.273) \times 0.15 = 0.18\,(m^3)$$

$$\therefore n = \frac{0.18}{0.49} = 0.37$$

tc ：地表面から根かせの中心までの深さ（03m）

$$\therefore t'o = \frac{2}{3}\left(\frac{1.8^2 + 3 \times 0.37 \times 0.3^2}{1.8 + 2 \times 0.37 \times 0.3}\right) = 1.10\,(m)$$

$$Q = \frac{1}{12}\,(6\,m^2 - 8\,m + 3)$$

$$m = \frac{t'o}{t} = \frac{1.10}{1.8} = 0.61$$

$$\therefore Q = \frac{1}{12} \times (6 \times 0.61^2 - 8 \times 0.61 + 3) = 0.03$$

$$J = (t'o - tc)^2\ tc$$
$$= (1.10 - 0.3)^2 \times 0.3 = 0.192$$

K ： 土質係数 $(3 \times 10^6\ kg/m^4)$

$$\therefore F \leqq \frac{0.3 \times 3 \times 10^6 (0.273 \times 0.03 \times 1.8^4 + 0.18 \times 0.192)}{252 \times (9.1 \times 1.10)^2}$$

$$F \leqq 4.3 \cdots\cdots\cdots\cdots\cdots\cdots \text{OK}$$

従って設計基準２５を満足する。

A－４－３　支線の強度

電線路と直角方向の風圧荷重を支持する場合の計算

(1)　単　　柱

$$\frac{P}{F} \geqq \frac{K}{h_o \times 10^3}\left\{12.5S\Sigma 1Qdh + 500DoH^2 - \frac{100}{3} \times 10^3 kH^3\right\}$$

P　：支線の許容引張強さ（２５２０kg）

F　：支線の安全率（２５）

ho　：支線取付点の地表上の高さ（９ｍ）

S　：径間（１００ｍ）

d　：架渉線の直径（１３５㎜）

h　：架渉線の地表上の高さ（９１ｍ）

H　：支持物の地表上の高さ（９２ｍ）

Do　：支持物の地際における直径（２７３㎝）

k　：支持物の直径増加率（９／１０００）

K　：係数（０５）

$$\frac{2520}{2.5} \geqq \frac{0.5}{9\times10^3}\left\{12.5\times100\times10\times13.5\times9.1\times3+500\times27.3\times9.2^2 - \frac{100}{3}\times10^3\times\frac{9}{1000}\times9.2^3\right\}$$

$1008 > 307$ ..... OK

(2) H 柱

$$\frac{P}{F} \geqq \frac{K}{ho\times10^3}\left\{12.5S\Sigma10dh + 1000DoH^2 - \frac{200}{3}\times10^3\times kH^3\right\}$$

$$\frac{2520}{2.5} \geqq \frac{0.5}{9\times10^3}\left\{12.5\times100\times10\times13.5\times9.1\times3+1000\times27.3\times9.2^2 - \frac{200}{3}\times10^3\times\frac{9}{1000}\times9.2^3\right\}$$

$1008 > 358.4$ ..... OK

以上により設計基準2.5を満足する。

A－4－4 腕金及びアームタイの強度

最悪条件として33 KV Line の腕金（L＝2,800㎜），アームタイについて強度計算を行なう。

F ：安全率（2.5）

d_1 ：電線外径（0.0135 m）

w_1 ：電線重量（0.3852 kg/m）

T ：電線張力（1,000 kg）

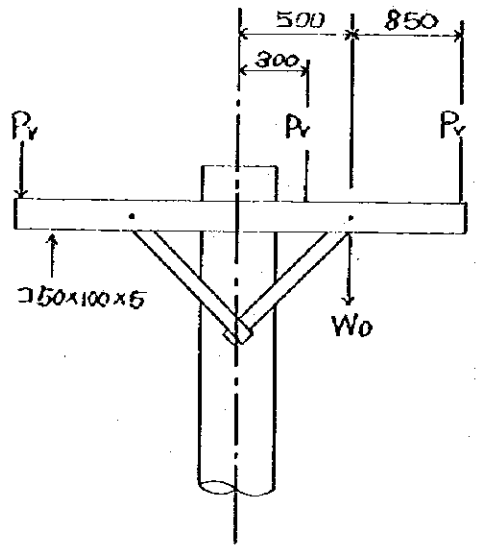
P_W ：風圧荷重（50 kg / m^2）

S ：径 間（100 m）

σ_a ：許容応力度

$$\sigma/F = \frac{4100}{2.5} = 1640\ kg/cm^2$$

(1) Suspension Pole



Pv = W1 × S + Wo

Wo = LP碍子の重量（10kg）

Pv = 0.3852 × 100 + 10

= 49 kg

(a) 腕 金 ⊐100 × 50 × 5 mm,

Length: 2800 mm

Z_1 ：断面係数（37.8 cm^3）

Mmax = Pv × 1

= 49 × 850

= 4165 (kg·cm)

$Z = Mmax/\sigma_a = \frac{4165}{1640} = 2.54\ (cm^3)$

$Z_1 \geqq Z$ (37.8 > 2.54) ..... OK

(b) アームタイ（3㎜ × 40㎜ × 750 ㎜）

$W_o = Pv \times 135/50 + Pv \times 30/50 = 162$ (kg)

Pk ：アームタイに作用する圧縮荷重

$Pk = W_o/\sin\theta = 217.3$ (kg)

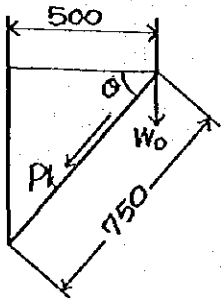
限界細長比 λ_o は，

$$\lambda_o = \pi\sqrt{\frac{E}{\sigma_y}} = 91$$

今回の細長比 λ は

$\lambda = L/r = 75/0.79 = 95$

$\lambda > \lambda_o$



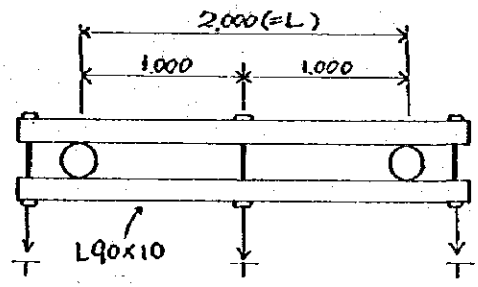
よってアームタイの座屈荷重 P_{ko} は

$$Pko = \pi \times E \times I / L^2 = \frac{\pi^2 \times 2.1 \times 10^6 \times 1.45}{75^2} = 5343 \text{ (kg)}$$

ここで安全率 2.5 であるので

$2.5 \times Pk = 543.2$ (kg) $<$ Pko ····· OK

(2) Terminal Pole



腕金（L 90㎜ × 10㎜，ℓ = 2800㎜）

Z_2 ：断面係数（19.5 ㎝³）

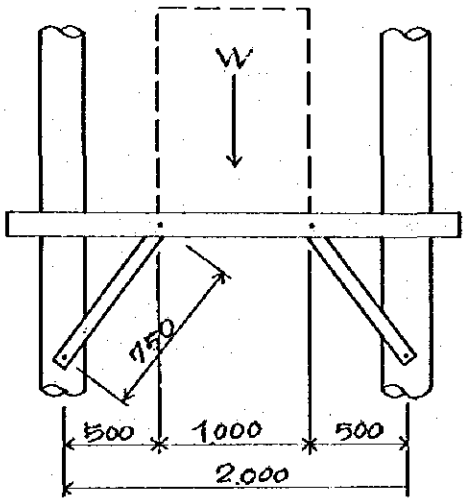
$Mmax = T \times L / 4$
$= 50000$ (kg·cm)

$2 \times Z = Mmax/\sigma_a$
$= 30.5$ (cm³)

$\therefore Z = 15.3$ (cm³)

$Z_2 \geqq Z$ (19.5 > 15.3) ····· OK

(3) Transformer Platform（300 KVA）



W = 2000 kg

腕金（ㄷ 100×50×5mm；ℓ = 2800mm）

$Mmax = W \times L / 4$
$= 50000$ (kg·cm)

$2 \times Z = Mmax/\sigma_a$
$= 30.5$ (cm³)

$\therefore Z = 15.3$ (cm³)

$Z_1 \geqq Z$ (37.8 > 15.3) ····· OK

A－4－5　弛度計算

Basic data

Conductor:	ACSR 95	mm^2
Diameter:	13.5	mm
Cross-section:	111.5	mm^2
Weight of conductor:	385.2	kg/km
Modulus of elastisty:	8250	kg/mm^2
Temperature coefficient:	19.0×10^{-6}/deg.	
Max. tension:	3180	kg
Wind load at 10°C:	50	kg/m^2
Span:	50 to 150	m
Intervals of span:	10	m
Temperature:	10 to 90°	C
Intervals of temperature:	10°	C
Safety factor:	3	

Erection Sags

Span m \ Temp. °C	Sag	Tension	10 S	10 T	20 S	20 T	30 S	30 T	40 S	40 T	50 S	50 T	60 S	60 T	70 S	70 T	80 S	80 T	90 S	90 T
50	12 cm	1,021 Kg	14	851	18	685	23	529	31	394	41	293	50	227	66	200	84	148		
60	17	1,005	20	875	26	677	33	529	43	404	55	313	69	252	87	222	105	164		
70	24	986	29	823	35	668	45	529	57	415	71	332	86	274	105	241	125	178		
80	32	965	38	805	47	658	58	528	73	424	89	347	105	294	123	259	142	191		
90	41	943	49	788	60	648	74	528	90	433	108	362	125	312	143	275	162	203		
100	52	918	62	771	75	639	91	528	109	441	128	375	147	327	165	288	184	213		
110	65	894	77	752	92	630	110	528	130	447	150	387	170	342	191	301	214	222		
120	80	868	94	735	112	620	131	528	153	454	174	397	195	355	216	313	238	231		
130	95	858	113	718	133	612	154	526	177	460	200	407	221	367	243	323	267	280		
140	115	818	134	701	156	604	179	526	203	464	227	416	255	378	282	333	311	288		
150	136	795	158	687	180	602	206	526	230	470	255	424	280	388	305	342	332	296		

A-5 3 Phase Short Cicuit Current

Fig.III-6-6 3 PHASE SHORT CIRCUIT CURRENT

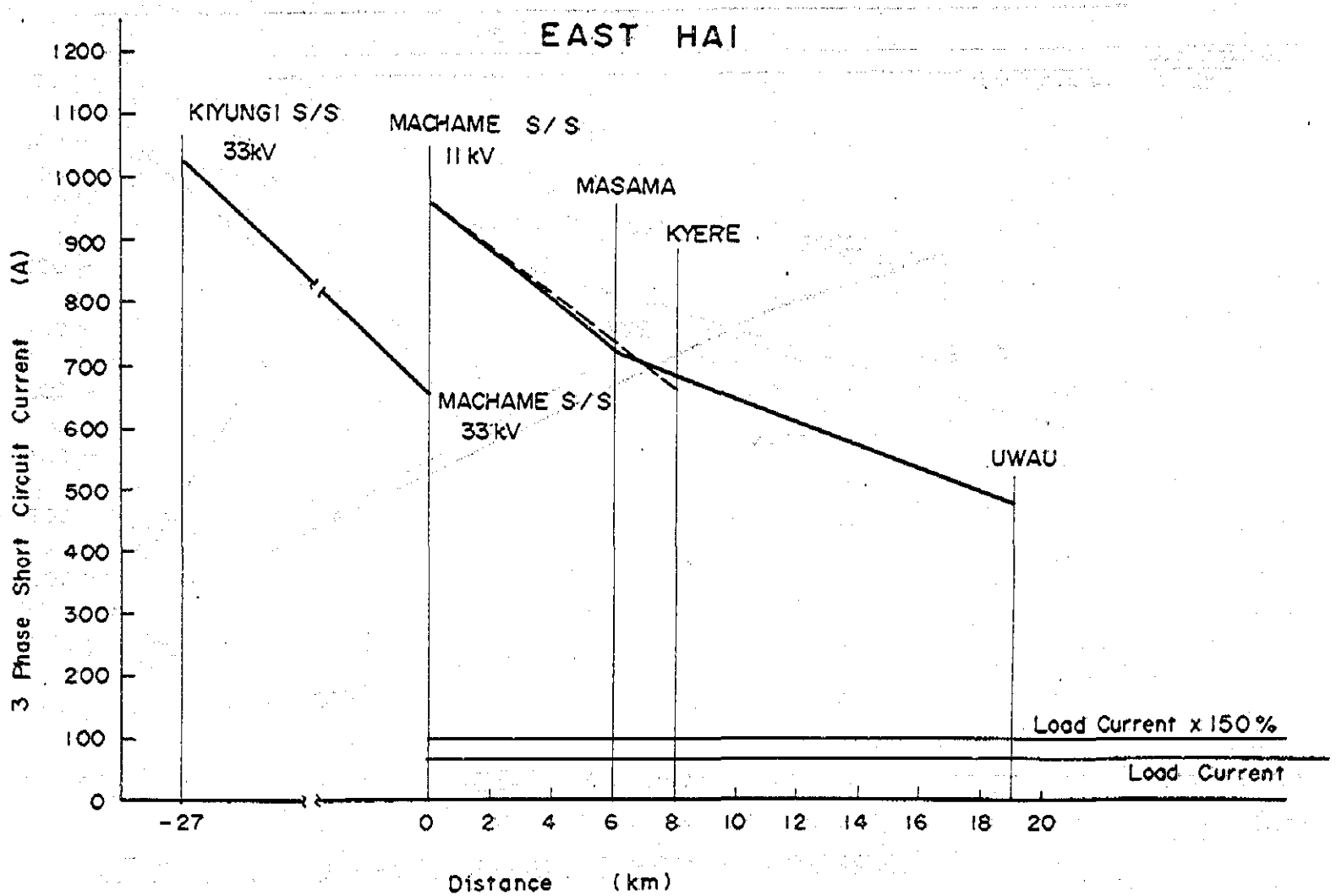


Fig.Ⅲ-6-7 3 PHASE SHORT CIRCUIT CURRENT

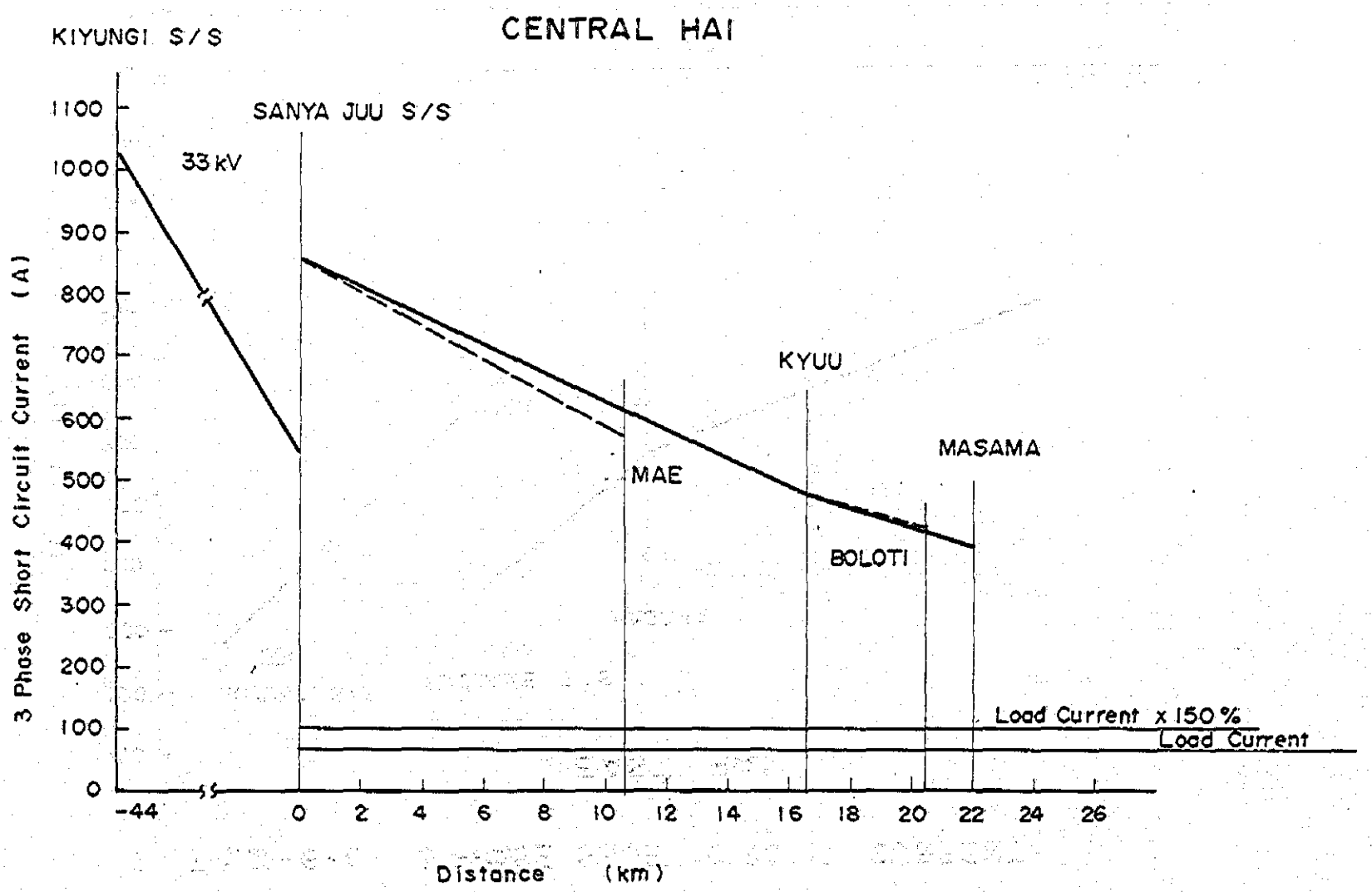


Fig. Ⅲ-6-8 3 PHASE SHORT CIRCUIT CURERNT

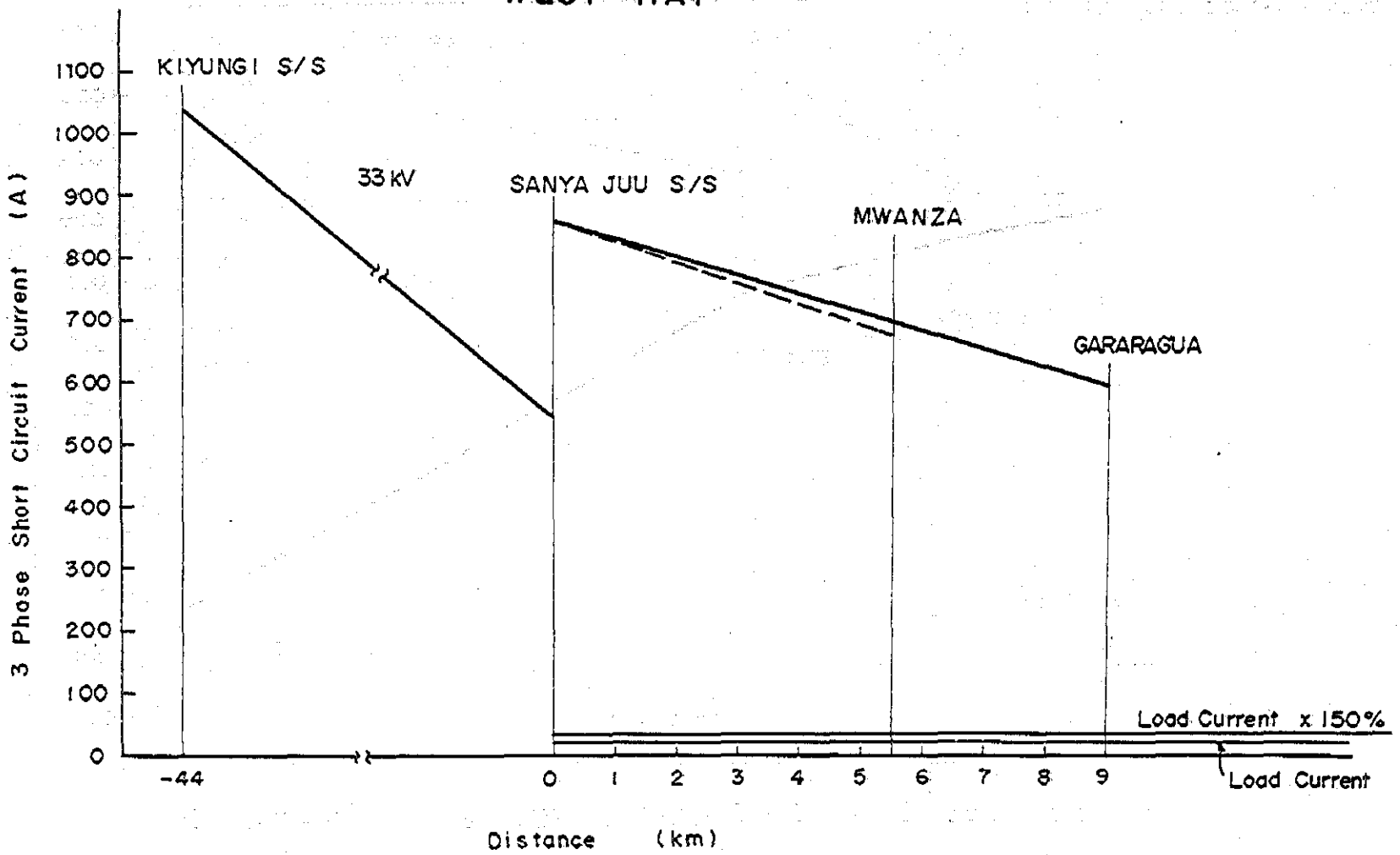


Fig.III - 6 - 9 3 PHASE SHORT CIRCUIT CURRENT

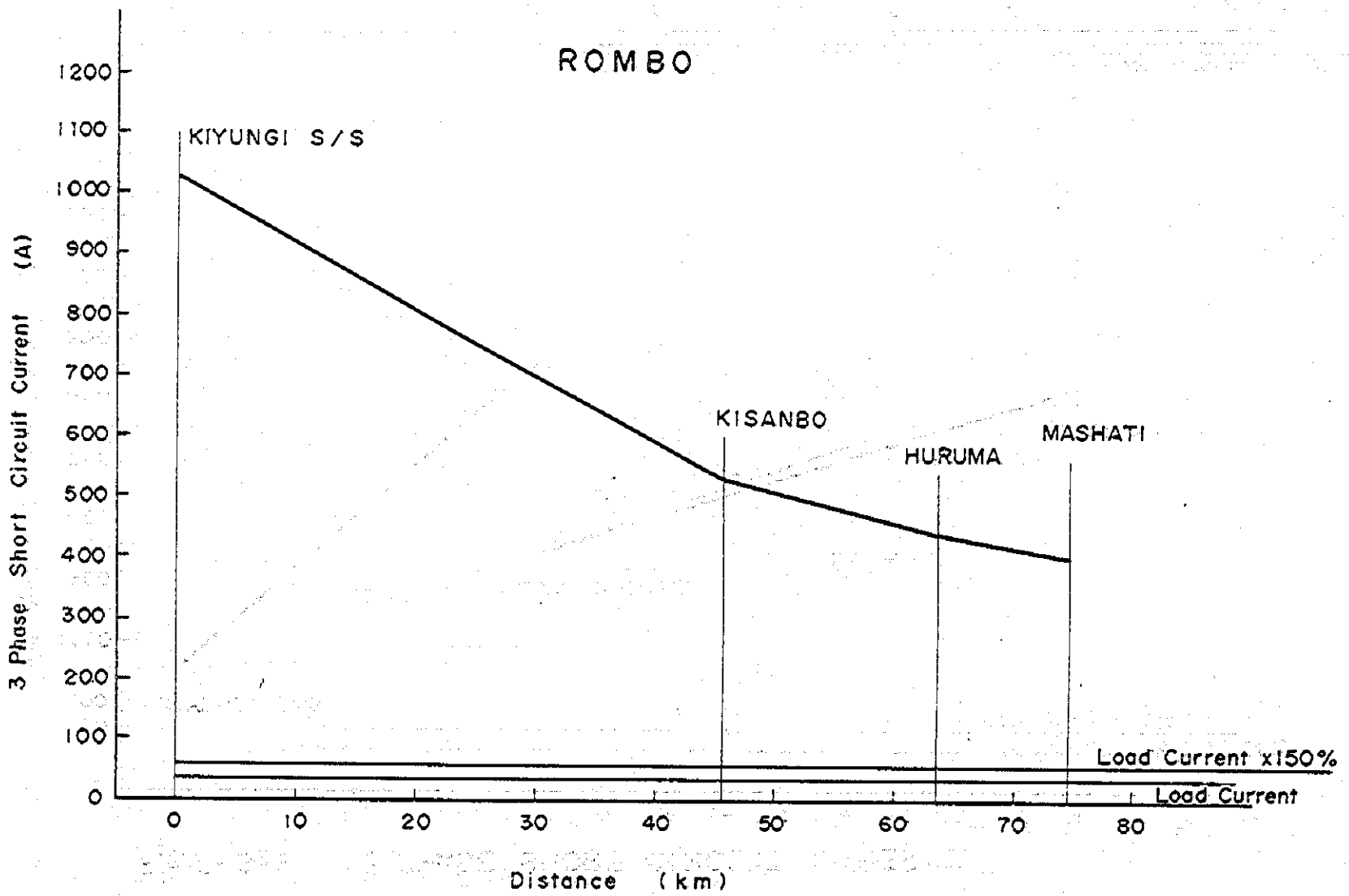


Fig.III-6-10 3 PHASE SHORT CIRCUIT CURRENT

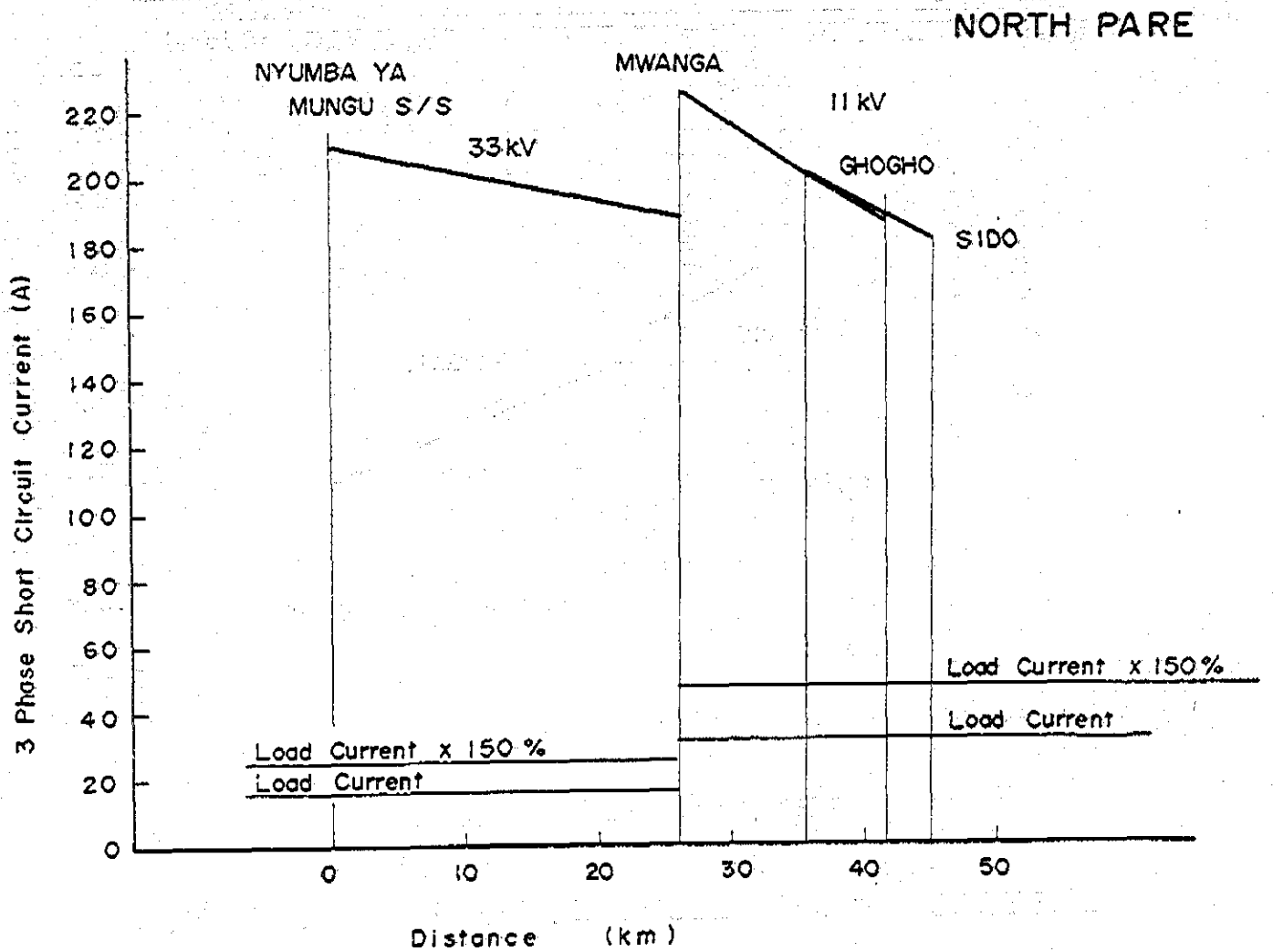
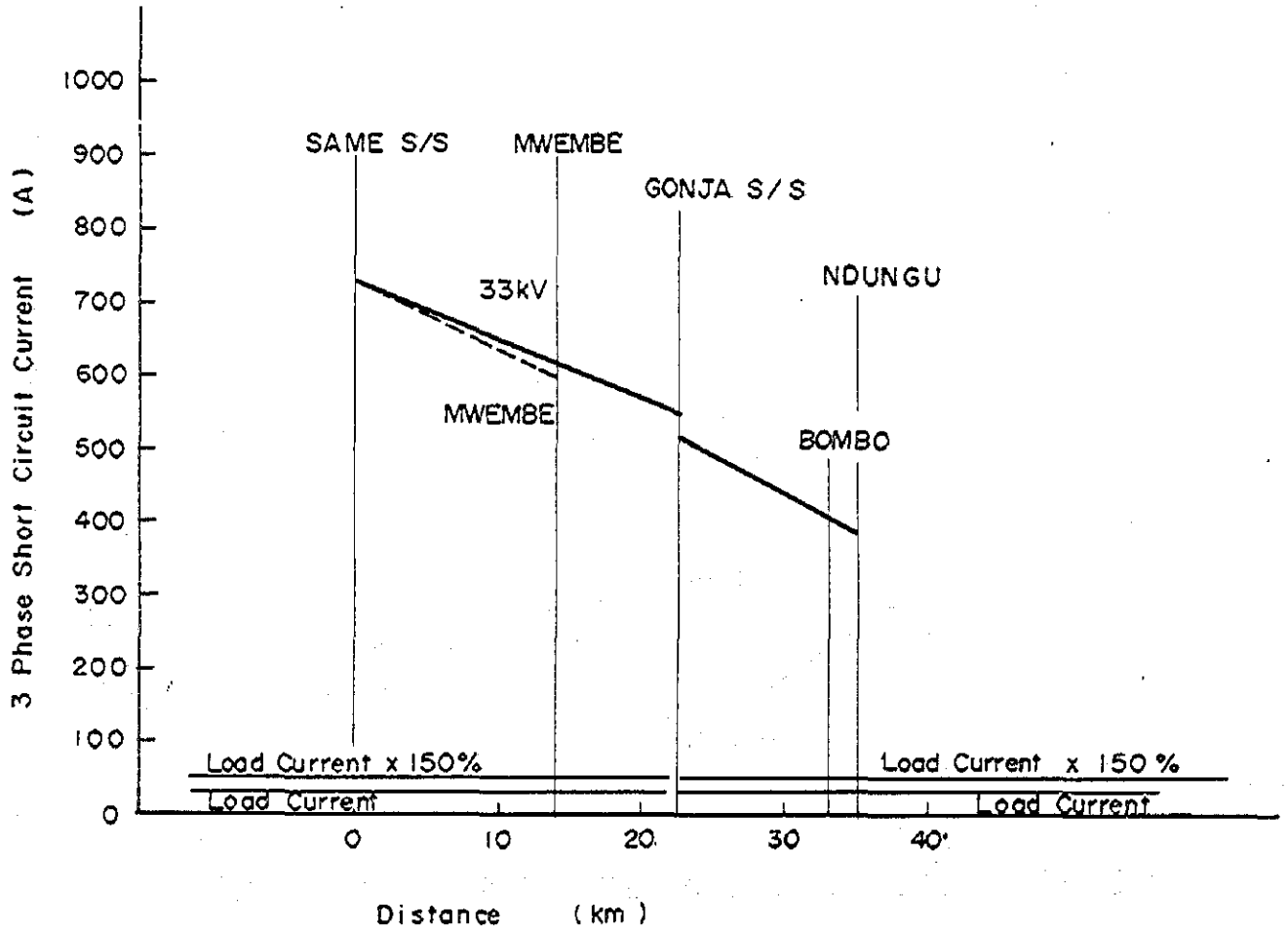
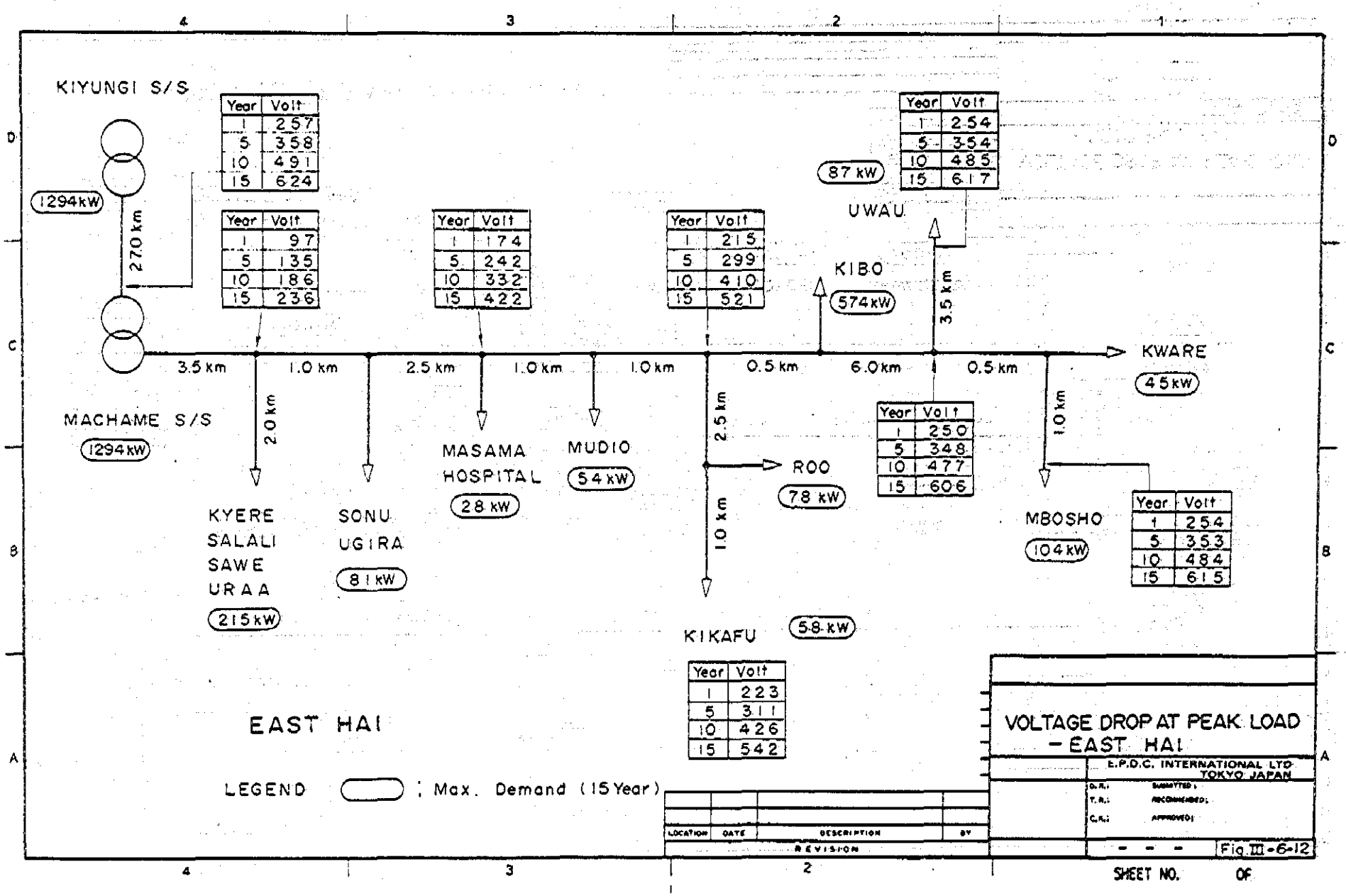


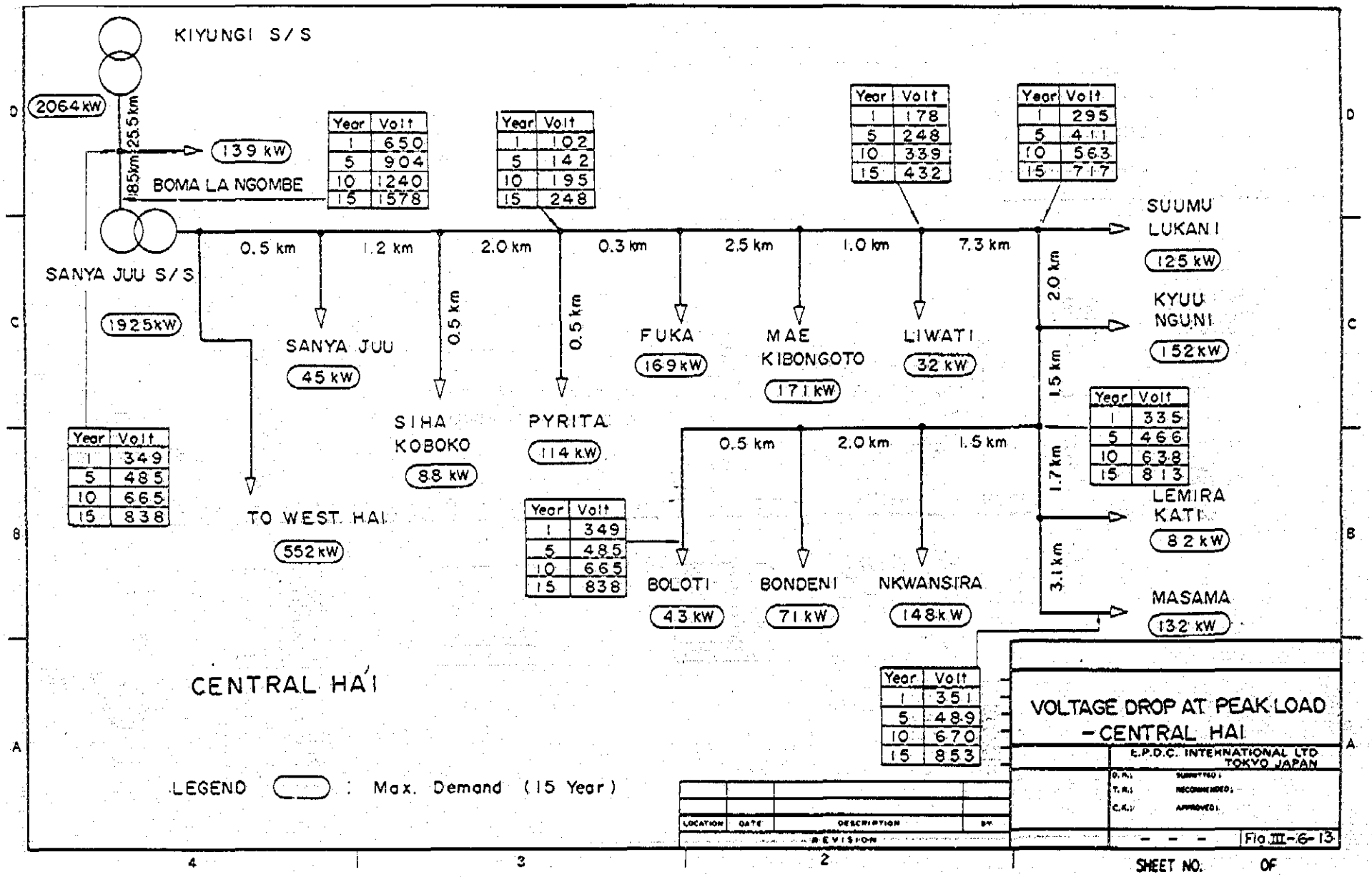
Fig. Ⅲ-6-11 3 PHASE SHORT CIRCUIT CURRENT

SOUTH PARE



A-6 Voltage Drop of Transmission and Distribution Line at Peak Load


KIYUNGI S/S
1294kW
27.0 km
MACHAME S/S
1294kW
3.5 km
1.0 km
2.0 km
KYERE
SALALI
SAWE
URAA
215kW
SONU
UGIRA
81kW
2.5 km
1.0 km
MASAMA
HOSPITAL
28kW
1.0 km
MUDIO
54kW
2.5 km
1.0 km
KIKAFU
58kW
0.5 km
6.0km
KIBO
574kW
87 kW
UWAU
3.5 km
0.5 km
KWARE
45kW
ROO
78 kW
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
Fig III-6-12
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

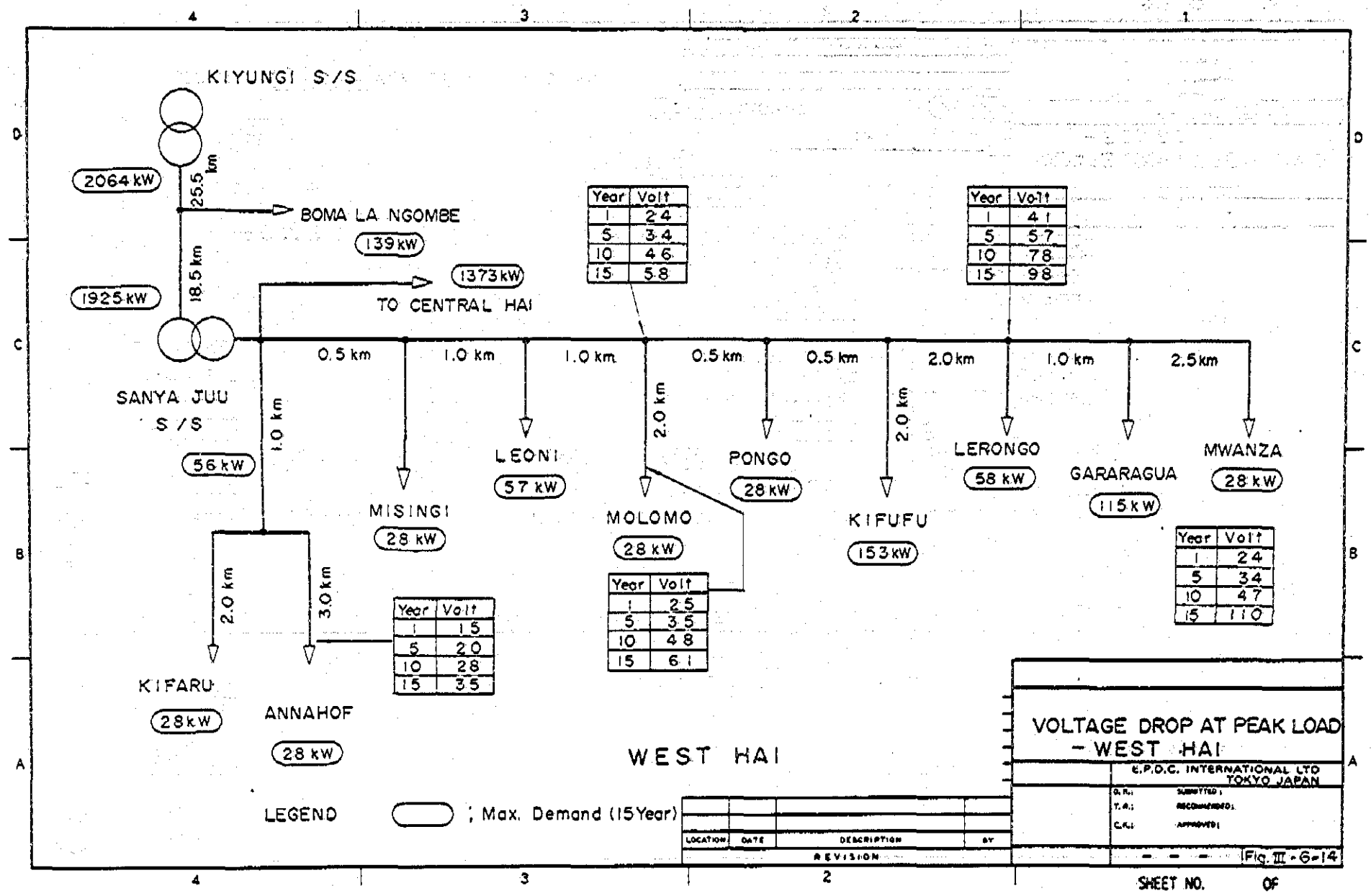
Year	Volt
1	295
5	411
10	563
15	717

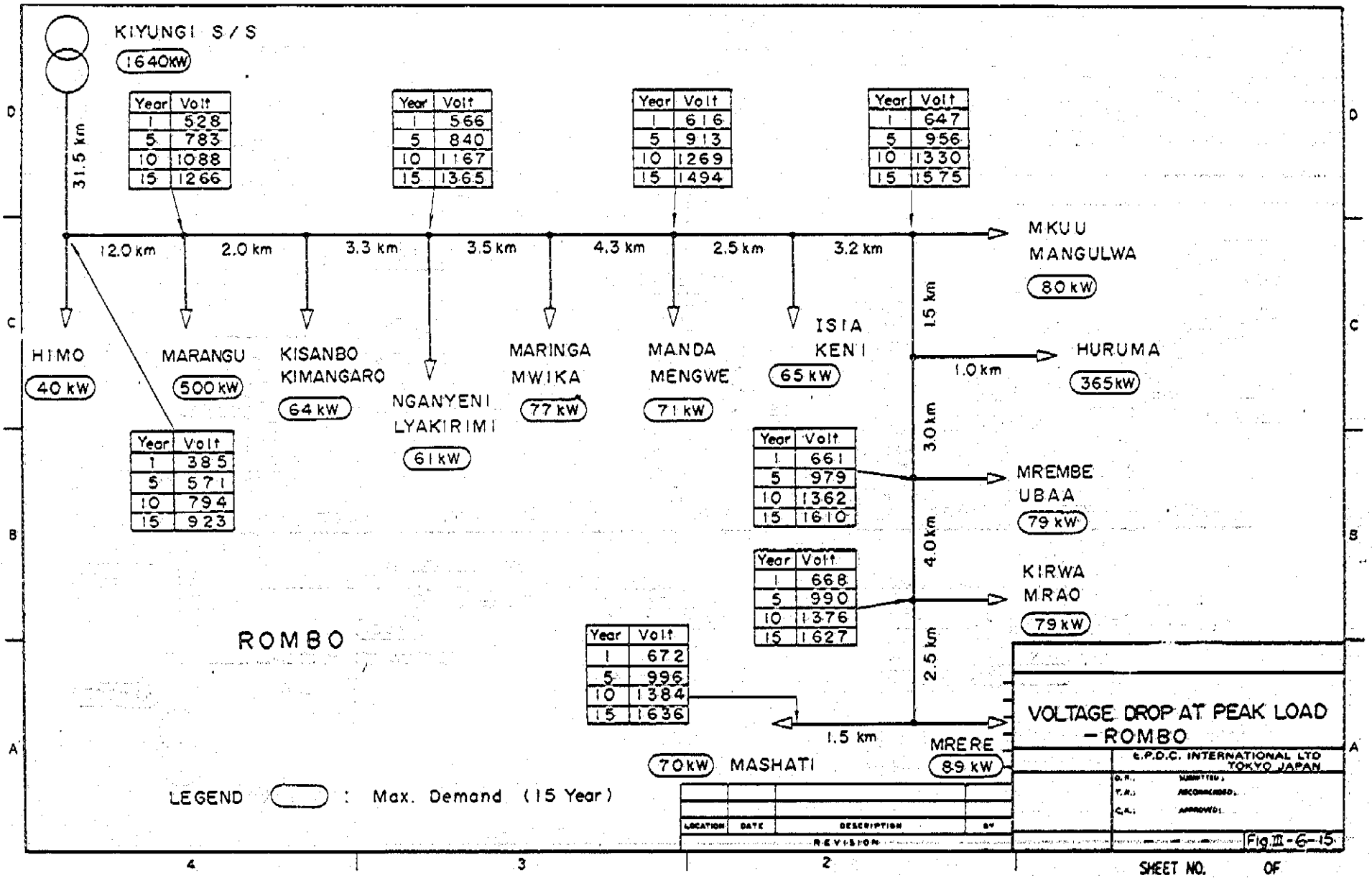
Year	Volt
1	349
5	485
10	665
15	838

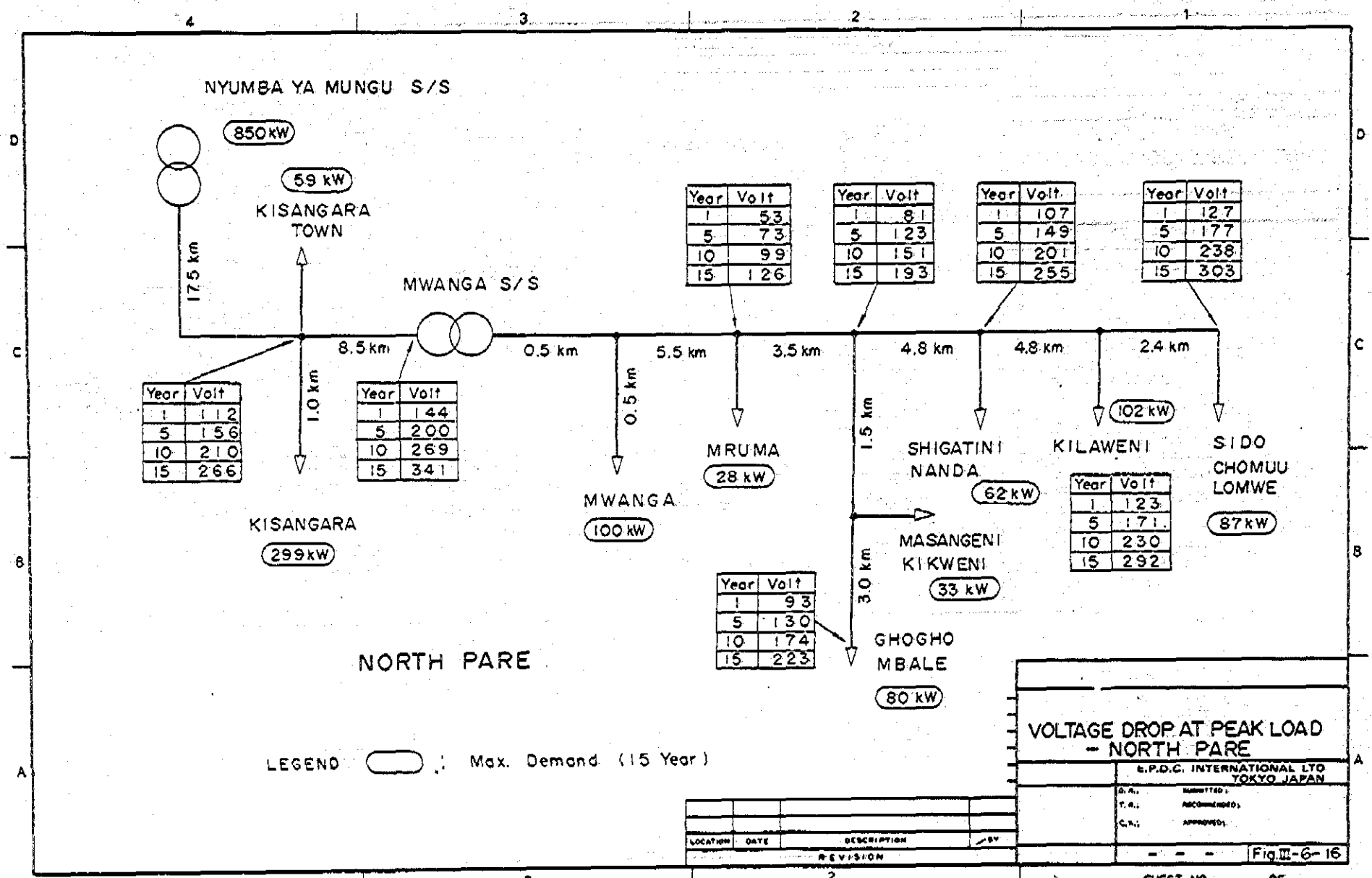
Year	Volt
1	349
5	485
10	665
15	838

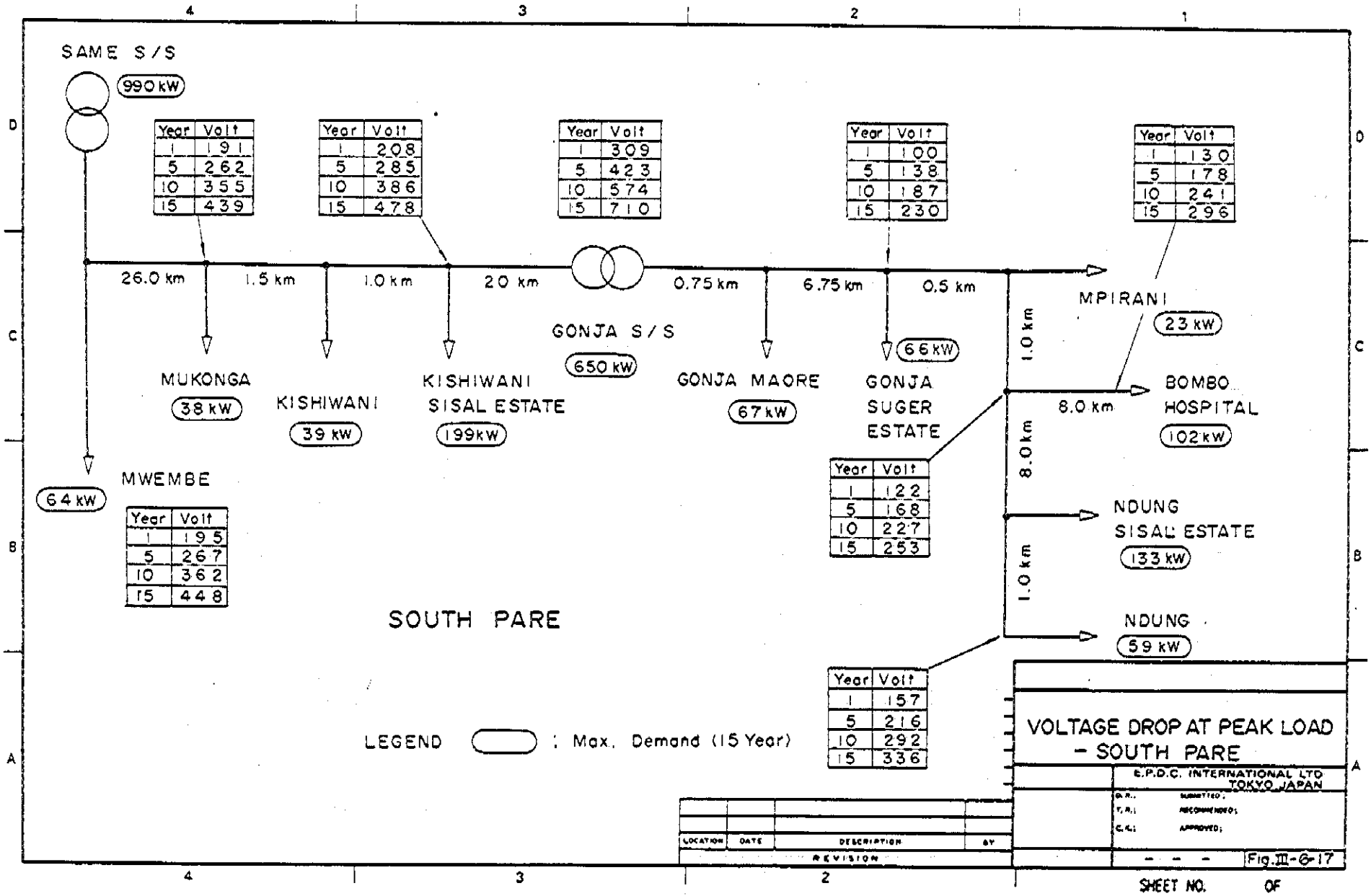
Year	Volt
1	335
5	466
10	638
15	813

Year	Volt
1	351
5	489
10	670
15	853


KIYUNGI S/S
2064 kW
25.5 km
BOMA LA NGOMBE
139 kW
1373 kW
TO CENTRAL HAI
1925 kW
18.5 km
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
Year Volt
1 24
5 34
10 46
15 58
Year Volt
1 41
5 57
10 78
15 98
Year Volt
1 24
5 34
10 47
15 110
Year Volt
1 25
5 35
10 48
15 61
Year Volt
1 15
5 20
10 28
15 35
WEST HAI
LEGEND ; Max. Demand (15Year)
VOLTAGE DROP AT PEAK LOAD - WEST HAI
E.P.D.C. INTERNATIONAL LTD TOKYO JAPAN
LOCATION DATE DESCRIPTION BY
REVISION
Fig. III-6-14
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.D.C. INTERNATIONAL LTD
TOKYO JAPAN
LOCATION DATE DESCRIPTION BY
REVISION
Fig.III-6-15
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
Fig.III-6-16
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
1.0 km
8.0 km
8.0 km
1.0 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
BOMBO HOSPITAL
102 kW
NDUNG SISAL ESTATE
133 kW
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.D.C. INTERNATIONAL LTD
TOKYO JAPAN
LOCATION | DATE | DESCRIPTION | BY
REVISION
Fig.III-6-17
SHEET NO. OF

A-7　低圧配電線路の電圧降下

A－7　低圧配電線路の電圧降下

25 KVA，50 KVAの変圧器による標準供給区域を配電した場合の電圧降下を次により計算する。

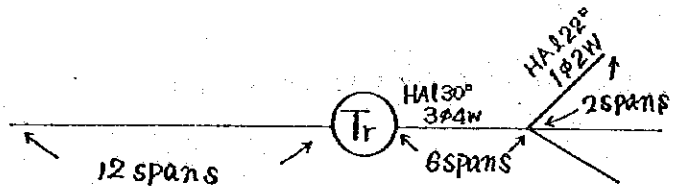
(1)　前提条件　　a．末端の電圧降下を16 V以下とする。

b．変圧器の利用率は100％

c．平等負荷であり，負荷電流は平衡しているものとし，幹線部分の亘長を全体の50％とする。

(2)　計算例

(1)　25 KVA



a．計算の条件

- HAℓ 22□ (1 φ 2 W)…… 1.530Ω/km
- HAℓ 30□ (3 φ 4 W)…… 0.983Ω/km
- 分散負荷率……平等分布負荷であるので50％
- 力率……90％とする。

b．計　　算

3 φ分　　$V_1 = \sqrt{3} \times 0.983 \times 0.3 \times \dfrac{12.5}{\sqrt{3} \times 400 \times 0.9} \times 0.5$

$= 5V$

1 φ分　　$V_2 = 2 \times 1.530 \times 0.1 \times \dfrac{12.5}{\sqrt{3} \times 400 \times 0.9} \times 0.5 \times \dfrac{1}{3} \times 0.5$

$= 0.51V$

全電圧降下　$Vo = \dfrac{5}{\sqrt{3}} + 0.51 = 3.4V$

（230 V電灯分）

(2)　50 KVA

a．計算の条件

- HAℓ 30□ (1 φ 2 W)…… 0.983Ω/km
- HAℓ 55□ (3 φ 4 W)…… 0.507Ω/km
- 分散負荷率……50％
- 力率……90％

b．計　　算

$$3\phi\text{分}\quad V_1 = \sqrt{3} \times 0.507 \times 0.6 \times \frac{25}{\sqrt{3} \times 400 \times 0.9} \times 0.5$$

$$= 11V$$

$$1\phi\text{分}\quad V_2 = 2 \times 0.983 \times 0.2 \times \frac{25}{\sqrt{3} \times 400 \times 0.9} \times 0.5 \times \frac{1}{3} \times 0.5$$

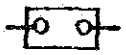
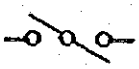
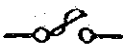
$$= 1.3V$$

$$\text{全電圧降下}\quad Vo = \frac{11}{\sqrt{3}} + 1.3 = 7.6V$$

（２３０Ｖ電灯分）

電圧降下は(a)，(b)に示す通りとなり，４％以内におさまる。

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 Transformer

Fig. III-7-1 Capacity & Location of Pole Transformers — Hai
Fig. III-7-2 Ditto — Rombo
Fig. III-7-3 Ditto — North Pare
Fig. III-7-4 Ditto — South Pore

Table III-7-1 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	50x3 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	50x2	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-7-2 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-7-3 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-7-4 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　予備品リスト

予備品リスト

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