添付資料(3) Calculation result of Transmission Line

1. Study of Transmission Line Capaciy

In case the line is comparatively short and the load is small, the transmission capacity is determined by current carrying capacity of the conductor.

Calculation formula, conditions and results of current carrying capacity.

Current carrying capacity of the conductor is calculated as follows:

$$I = \sqrt{\frac{\{hw+(hr - \frac{Ws}{\pi\theta})\eta\}\cdot\pi\cdot d\cdot\theta}{R20\ \{1+\alpha(t-20)\}.K}}$$

$$hr = 0.000567\frac{(\frac{273+T+\theta}{100})^4 - (\frac{273+T}{100})^4}{\theta} \quad (W/^\circ C\ cm^2)$$

$$hw = 0.00572\frac{\sqrt{\frac{v}{d}}}{(273+T+\frac{\theta}{2})^{0.123}} \quad (W/^\circ C\ cm^2)$$

Ws	: Solar radiation energy	(W/cm^2)
R20	: D.C. Resistant at 20°C	(Ω/cm)
V	: Wind velocity	(m/sec)
d	: Diameter of conductor	(cm)
T	: Ambient temperature	(°C)
θ	: Temperature raise	(°C)
t	: Max. temperature of conductor (=T+θ)	(°C)
α	: Temperature coefficient (ACSR=0.004)	
η	: Thermal emissivity of conductor	
K	: Conversion coefficient of A.C resistance	

Following particulars are specified for the calculation of current capacity of conductors.

Max. Temperature of conductor	70°C
Max. Ambient temperature	40°C
Wind velocity	0.5 m/sec.
Thermal emissivity of conductor	0.9
Solar radiation energy (not specified)	0.1 W/cm^2
Conversion coefficient of A.C resistance	95mm^2: 1.21 58mm^2: 1.13 32mm^2: 1.09

Result of calculation is as follows:

Size of conductor (mm^2)	Composition Aℓ + st (Nos./mm)	Dia. of conductor (cm)	Resistant at 20°C (ohm/cm)	Current capacity (A)
ACSR 95	6 / 4.5 + 1 / 4.5	1.35	0.00000301	207
ACSR 80	6 / 4.2 + 1 / 4.2	1.26	0.00000345	
ACSR 58	6 / 3.5 + 1 / 3.5	1.05	0.00000497	158
ACSR 32	6 / 2.6 + 1 / 2.6	0.78	0.00000899	117

The transmission capacity determined by conductor current carring capacity per circuit to be obtained with the assumption of load power factor cos. ψ = 0.9 is shown below.

Line voltage (kV)	Conductor (mm^2)	Transmission capacity/cct (MW)
33	ACSR 95	10.6
	ACSR 80	
	ACSR 58	8.1
	ACSR 32	5.7

2. Study of Voltage Drop

Voltage drop is expressed as Vs-Vr and voltage drop ratio as (Vs-Vr)/Vr.

Generally in the case of long distance transmission line, it is to be considered as distributed constant circuit where line constant is uniformly distributed.

From the initial stage, as it was envisaged that voltage drop would be large due to long line length, the following countermeasures and conditions were set up.

A) To improve load power factor as much as possible at load side.

For the calculation, cosc = 0.9 is used.

In order to assist to improve power factor up to cosc=0.9, setting of shunt capacitor at substation with capacity to a extent that most of Var is compensated is recommendable.

Calculation results of voltage drop is shown below:

Voltage drop ratio (%):

Kumasi S/S o———— 33 kV, 42 km ————o Bekwai S/S

Conductor mm^2	Power factor cos rs	Voltage drop $\frac{Vn-En}{En}$ x 100(%)
ACSR 95	0.92	3.94
ACSR 80	0.92	4.55
ACSR 58	0.93	6.06

For the purposes of the above voltage drop study and the followed power loss study, line constants of R, L, C, are calculated as shown in App. -1.

2-2 Study Results of Votlage Drop (%)

A) Project Part 1

Kumasi S/S - Bekwai S/S : 42 km, 33 kV (11 kV)

Conductor (mm^2)	Power factor ($\cos\theta s$)	Sending Voltage (kV)	Voltage Drop (%)
ACSR 95	0.92 (0.87)	34,300 (14,900)	3.94 (35.45)

B) Project Part 2

Daboase Junction - Komenda S/S : 28 km, 33 kV (11 kV)

Conductor (mm^2)	Power factor ($\cos\theta s$)	Sending Voltage (kV)	Voltage Drop (%)
ACSR 58	0.94 (0.91)	33,500 (12,600)	1.52 (14.55)
ACSR 32	0.94 (0.90)	33,900 (13,600)	2.73 (23.64)

C) Project Part 3

Tokuse S/S - Senya Beraku : 39 km, 33 kV (11 kV)

Conductor (mm^2)	Power factor ($\cos\theta s$)	Sending Voltage (kV)	Voltage Drop (%)
ACSR 58	0.96 (0.91)	33,600 (13,000)	1.82 (18.18)
ACSR 32	0.96 (0.90)	34,100 (14,300)	3.33 (30.00)

3. Study of Power Loss

Transmission losses which occur on the transmission systems are conductor resistance loss, transmission line corona loss, and substation transformer loss. In the present case, the corona loss can be neglected, because the planned line is below 138kV. Therefore, only corona and transformer losses are treated below.

The conductor resistance loss, is a strict sense, can be obtained from the loss circle diagram. However, for the projected line, it is assumed that the power loss will not reach a critical point as compared with the voltage drop. For this reason, the conductor resistance loss can be obtained from the following:

$$P_L = \eta I^2 Rl \quad (W)$$

Based on the line constants shown in App. -1 R.L.C. calculation, the study results are shown below.

Transmission loss (kW):

Kumasi S/S —— 33 kV, 42 km —— Bekwai S/S

Conductor mm²	Power factor cos rs	Transmission loss (kW)
ACSR 95	0.92	181
ACSR 80	0.92	219
ACSR 58	0.93	393

3-2 Study Results of Power Loss (KW)

A) Project Part 1

Kumasi S/S - Bekwai S/S : 42 km, 33 kV (11 kV)

Conductor (mm^2)	Power factor ($\cos\theta s$)	Transmission loss (kW)
ACSR 95	0.92 (0.87)	181 (1,922)

B) Project Part 2

Daboase - Komenda S/S : 28 km, 33 kV (11 kV)

Conductor (mm^2)	Power factor ($\cos\theta s$)	Transmission loss (kW)
ACSR 58	0.94 (0.91)	32 (370)
ACSR 32	0.94 (0.90)	70 (574)

C) Project Part 3

Tokuse S/S - Senya Beraku : 39 km, 33 kV (11 kV)

Conductor (mm^2)	Power factor ($\cos\theta s$)	Transmission loss (kW)
ACSR 58	0.96 (0.91)	37 (414)
ACSR 32	0.96 (0.90)	71 (648)

1) Inductance

For fault calculation, self- and mutual inductance in earth return circuits are calculated and used. For line constant calculations, however, the general method is that working inductance is calculated and used by the following formula under the condition that line constant in every phase is of the same value by means of transposition.

$$L = 0.05 + 0.4605 \log_{10}\frac{D}{r} \quad \text{(mH/km)}$$

$$D = 3\sqrt{Dab \cdot Dbc \cdot Dca} \quad \text{(m)}$$

$$X_1 = 2\pi fL \quad \text{(ohm/km)}$$

2) Capacitance

Working capacitance is calculated and used in the same way as working inductance, on the basis of the following formula, under the condition that line constant in every phase is of the same value by means of transposition.

$$C = \frac{0.02413}{\mathrm{Log}_{10}\frac{D}{r}} \quad (\mu\text{F/km})$$

$$D = 3\sqrt{Dab.Dbc.Dca} \quad \text{(m)}$$

$$B = 2\pi fc \quad \text{(mho/km)} \qquad f=50\text{(Hz)}$$

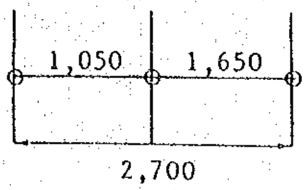
$$2\pi f=314$$

3) Phase arrangement and equivalent distance

According to the tower design, equivalent distance is calculated under the following phase arrangement.

33 kV   1 cct

D = 1.67 (m)



4) Conductor resistance

$R_{70} = R_{20}\ \{1 + \alpha\ (t - 20)\}$ (ohm/km)

R_{20} : DC resistance at 20°C (ohm/km)

α : Coefficient between temperature and resistance (/°C)

ACSR : 0.0040

t : Allowable temperature

ACSR : 70°C

5) Calculation result of R.L.C.

Line voltage condutor (mm^2)	r (m) $\times 10^{-2}$	D (m)	L (mH/km)	X_1 (Ω/km)	C (μF/km)	B (℧/km) $\times 10^{-6}$	R70 (Ω/km)
33 kV							
ACSR 95	1.35	1.67	1.014	0.3184	0.011532	3.6229	0.361
ACSR 80	1.26	1.67	1.027	0.3225	0.011370	3.5720	0.414
ACSR 58	1.05	1.67	1.064	0.3341	0.010961	3.4435	0.596

5)-2 Calculation result of R.L.C.

Line voltage condutor (mm^2)	r (m) $\times 10^{-2}$	D (m)	L (mH/km)	X_1 (Ω/km)	C (μF/km)	B (℧/km) $\times 10^{-6}$	R70 (Ω/km)
33 kV							
ACSR 58	1.05	1.67	1.064	0.3341	0.010961	3.4435	0.596
ACSR 32	0.78	1.67	1.123	0.3526	0.010353	3.2508	1.079

1) Resistance at working temperature (at 70°C)

Name of conductor (mm^2)	R70 (Ω/km)
ACSR 95	0.361
ACSR 80	0.414
ACSR 58	0.596

2) Reactance

Name of conductor (mm^2)	X (Ω/km)
ACSR 95	0.318
ACSR 80	0.323
ACSR 58	0.334

3) Susceptance (or Blindleilwert)

Name of conductor (mm^2)	B ($\mho$/km)x10^{-6}
ACSR 95	3.623
ACSR 80	3.572
ACSR 58	3.444

4) Impedance

Conductor (mm^2)		
ACSR 95	$\dot{z}_1 = 0.361 + j0.318$	(Ω/km)
ACSR 80	$\dot{z}_2 = 0.414 + j0.323$	(")
ACSR 58	$\dot{z}_3 = 0.596 + j0.334$	(")

5) Admittance

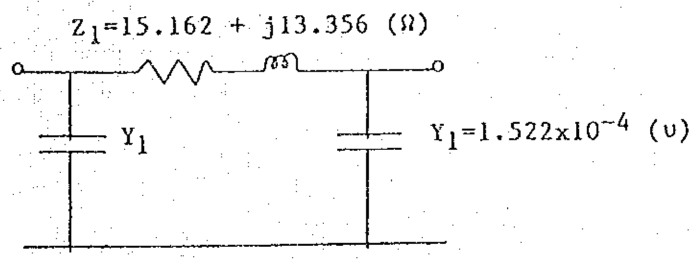
Conductor (mm^2)		
ACSR 95	$\dot{y}_1 = j3.623 \times 10^{-6}$	(mho/km)
ACSR 80	$\dot{y}_2 = j3.572 \times 10^{-6}$	(")
ACSR 58	$\dot{y}_3 = j3.444 \times 10^{-6}$	(")

6) Impedance and Admittance for 42 km

$Z_x = z_x \times 42$ (Ω)

$Y_x = y_x \times 42$ (℧)

Conductor (mm^2)	R (Ω/km)	X (Ω/km)	B (℧/km$\times 10^{-4}$)
ACSR 95	$Z_1 = 15.162$	$+ j13.356$	$Y_1 = j1.522$
ACSR 80	$Z_2 = 17.388$	$+ j13.566$	$Y_2 = j1.500$
ACSR 58	$Z_3 = 25.032$	$+ j14.028$	$Y_3 = j1.446$



* in case of ACSR 95mm^2 Conductor

7) Calculation

Sending - voltage ——

Receiving - voltage 33 (kV)

Receiving - power 3,600 (kW)

Phase voltage at receiving end = $33/\sqrt{3}$ = 19.05 (kV)

Receiving power for one conductor = 3,600/3 = 1,200 (kW)

Power factor = 0.9

Current for one conductor:

1,200/19.05/0.9 = 70.0 (A) .... Apparent current

Apparent power = 1,200/0.9 = 1,333 (kVA)

$\cos\Theta = 0.9 \longrightarrow \sin\Theta \fallingdotseq 1-(0.9)^2 = 0.4359$

Apparent current = 70.0 (A) (1,333 kVA)

Effective current = 70.0 x 0.9

= 63.0 (A) (1,200 kW)

Reactive current = 70.0 x 0.4359

= 30.5 (A) (581 KVAR)

Receiving-end current

$$\dot{I}_r = 63.0 - j30.5 \text{ (A)}$$

$$= 0.063 - j0.0305 \text{ (kA)}$$

Sending-end voltage

$$\dot{E}_s = \dot{E}_r\left(1 + \frac{\dot{Z}\dot{Y}}{2}\right) + \dot{Z}\dot{I}_r$$

Sending-end voltage Vn and current $\dot{I}s$

$$\dot{V}_n = K_A\dot{E}_n + K_B\dot{I}_r$$

$$\dot{I}_s = K_A\dot{I}_r + K_c\dot{E}_n$$

$$Z = R + jX = \sqrt{R^2 \times X^2} \quad \angle \tan^{-1}\frac{X}{R}$$

$$Y = jb$$

添付資料(4) 弛 度 計 算 書

1. Design Data

1.1 Conductor and Span Data

33kV lines :

Conductors (mm^2)	ACSR, 58, 95
Max. Conductor Tention at wind load (kg)	600, 700
Spans. (m)	70, 80, 90, 100, 110, 120, 130

1.2 Temperatures

Max. Ambient Temperature	40℃
Min. Temperature of Conductor	0℃
Max. Temperature of Conductor	70℃
Every Day Temperature of Conductor	25℃
Temperature of Conductor in Max. Wind Condition	10℃

1.3 Wind load for Lines

	Wind pressure (kg/m^2)
Poles with cross Section	55 (21m/s)
Conductors	44 (19m/s)
(Average)	50 (20m/s)

1.4 Safety Factor

Normal loading Condition	3.0

（ ACSR 95mm² の場合 ）

2. 電線の諸規格値

2.1 アルミ素線について

断面積	$A_a = \pi d_a^2/4$	$4.5^2 \times \pi/4 = 15.90$mm²
引張強さ	$t_a = 18.5 - 0.7 d_a$	$18.5 - 0.7 \times 4.5 = 15.35$kg/mm²
抗張力	$T_a = A_a, t_a$	$15.90 \times 15.35 = 244.0$kg
素線一本の重量	W_a = 比重 $\times S_a$	$2.70 \times 15.90 \times 10^{-2} \times 10^2 = 42.93$g/m (g/cm³)

2.2 鋼素線について

A_s	$4.5^2 \times \pi/4 = 15.90$mm²
t_s ($d_s = 4.0 - 4.5$mm)	125kg/mm²
T_s	$125 \times 15.90 = 1,988$kg
W_s	$7.8 \times 15.9 \times 10^{-2} \times 10^2 = 124.02$g/m

2.3 撚線として

抗張荷重 $T_c = 0.9\ (t_a A_a N_a + t_s A_s N_s)$

$= 0.9\ (244 \times 6 + 1,988 \times 1) = 3,107$kg

重量 $W_c = 1.02\ (N_a W_a + N_s W_s)$

$= 1.02\ (6 \times 42.93 + 1 \times 124.02) = 389$g/m

$= 0.389$kg/m

計算切断面積 $S_a = A_a \times N_a$　$15.9 \times 6 = 95.4$mm²

$S_s = A_s \times N_s$　$15.9 \times 1 = 15.9$mm²

合計 $S_o = S_a + S_s$　111.3mm²

アルミ部の断面積と鋼心部のそれとの比 (m)

$m = S_a / S_t$　$95.4 / 15.9 = 6$

外径 (㊇) $D = 4.5 \times 2$層 $\div 4.5 \times 1$層 $= 13.5$mm

等価弾性係数 $E=\dfrac{mE_a+E_s}{m+1}$

$=\dfrac{6\times6.3+21.0}{6+1}\times10^3=8,400kg/mm^2$

等価線膨張係数 $\alpha=\dfrac{m\alpha_aE_a+\alpha_sE_s}{mE_a+E_s}$

$=\dfrac{6\times23\times6.3+11.5\times21}{6\times6.3+21}\times10^{-6}=18.9\times10^{-6}℃$

2.4 負荷係数（q_1）

設計最悪状態としては最低温度（0℃），50kg/m²，風圧（P_0）を考えると。

風圧荷重 $W_w=P_0\times D\times10^{-3}$

$=50\times13.5\times10^{-3}=0.675kg/m$

自　　重 W_c $=0.389kg/m$

∴合成荷重 $W_0=\sqrt{W_c{}^2+W_w{}^2}$

$=\sqrt{0.389^2+0.675^2}=0.779kg/m$

よって，負荷係数 $q_1=W_0/W_c$

$=0.779/0.389=2.003$

2.5 弛度計算

電線単位長・単位切断面積当りの重量（δ）

$\delta=W_c/S_0$

$=0.389/111.3=0.003495kg/m\text{-}mm^2$

最大使用張力 700kg

安全率 3,107／700＝4.4＞3

単位切断面積当りの最大使用張力（f_1）

$f_1=700/111.3=6.29kg/mm^2$

よって，$k=f_1-\dfrac{(q_1\delta)^2S^2E}{24f_1{}^2}$

$$=6.29-\frac{(2.003\times0.003495)^2\times S^2\times8,400}{24\times6.29^2}$$

又，$M=\dfrac{(q_2\delta)^2S^2E}{24}$

$$=\frac{(1\times0.003495)^2\times S^2\times8,400}{24}$$

更に，温度差（t℃）＝70－0＝70℃であるので，

∴　$\alpha tE=18.9\times10^{-6}\times70\times8,400=11.11$

又，$f_2^2\{f_2-(K-\alpha tE)\}=M$ より f_2 を求める。

∴弛度（D）＝$\delta q_2S^2/8f_2$

$=0.003495\times1\times S^2/8\times f_2$（m）

その時の架線張力（T）＝f_2S

$=f_2\times111.3$（kg）

電線実長（L_o）＝$S\{1+\dfrac{8}{3}(\dfrac{D}{S})^2\}$（m）

以上の計算を整理すると各Spanに対する夫々の値は次のようになる。

Span（S）：	（m）	70	80	90	100	110	120	130
K：$=f_1-\dfrac{(q_1\delta)^2S^2E}{24f_1^2}$		4.17	3.52	2.78	1.95	1.04	0.05	-1.03
M：$=\dfrac{(q_2\delta)^2S^2E}{24}$		20.95	27.36	34.63	42.75	51.73	61.56	72.25
$K-\alpha tE$		-6.94	-7.59	-8.33	-9.16	-10.07	-11.06	-12.14
f_2：$f_2^2\{f_2-(K-\alpha tE)\}=M$		1.57	1.72	1.85	1.96	2.07	2.16	2.24
D：$=\dfrac{\delta q_2S^2}{8f_2}$	（m）	1.36	1.63	1.91	2.23	2.55	2.91	3.30
T：$=f_2\cdot S$	（kg）	175	192	206	218	230	240	249
L_o：$=S\{1+\dfrac{8}{3}(\dfrac{D}{S})^2\}$	（m）	70.07	80.09	90.11	100.13	110.16	120.19	130.22

（ ACSR 58mm² の場合 ）

3. 電線の諸規格値

3.1 アルミ素線について

断　面　積　$A_a = \pi d_a^2/4$　　$3.5^2 \times \pi/4 = 9.62$mm²

引 張 強 さ　$t_a = 18.5 - 0.7 d_a$　　$18.5 - 0.7 \times 3.5 = 16.05$kg/mm²

抗　張　力　$T_a = A_a . t_a$　　$9.62 \times 16.05 = 154.4$kg

素線一本の重量　W_a ＝比重×S_a　　$2.70 \times 9.62 \times 10^{-2} \times 10^2 = 25.97$g/m
(g/cm³)

3.2 鋼素線について

A_s　　$3.5 \times \pi/4 = 9.62$mm²

t_s (d_s=3.0−4.0mm)　　130kg/mm²

T_s　　$130 \times 9.62 = 1,251$kg

W_s　　$7.8 \times 9.62 \times 10^{-2} \times 10^2 = 75.04$g/m

3.3 撚線として

抗 張 荷 重　$T_c = 0.9\ (t_a A_a N_a + t_s A_s N_s)$

$= 0.9\ (154.4 \times 6 + 1,251 \times 1) = 1,960$kg

重　　量　$W_c = 1.02\ (N_a W_a + N_s W_s)$

$= 1.02\ (6 \times 25.97 + 1 \times 75.04) = 235$g/m

$= 0.235$kg/m

計算切断面積　$S_a = A_a \times N_a$　$9.62 \times 6 = 57.7$mm²

$S_s = A_s \times N_s$　$9.62 \times 1 = 9.6$mm²

合　計　$S_o = S_a + S_s$　67.3mm²

アルミ部の断面積と鋼心部のそれとの比（m）

$m = S_a / S_s$　　$57.7/9.6 = 6.01$

外　径（※3）$D = 3.5 \times 2$層$+ 3.5 \times 1$層　＝10.5mm

等価弾性係数　$E=\dfrac{mE_a+E_s}{m+1}$

$$=\frac{6.01\times6.3+21.0}{6+1}\times10^3=8,400\text{kg/mm}^2$$

等価線膨張係数　$\alpha=\dfrac{m\alpha_aE_a+\alpha_sE_s}{mE_a+E_s}$

$$=\frac{6.01\times23\times6.3+11.5\times21}{6.01\times6.3+21}\times10^{-6}=18.9\times10^{-6}℃$$

3．4　負荷係数（q_1）

設計最悪状態としては最低温度（0℃），50kg/m²，風圧（P_o）を考えると。

風圧荷重　$W_w=P_o\times D\times10^{-3}$

$=50\times10.5\times10^{-3}=0.525$kg/m

自　　重　W_c　　　　　　　$=0.235$kg/m

∴合成荷重　$W_o=\sqrt{W_c{}^2+W_w{}^2}$

$=\sqrt{0.235^2+0.525^2}=0.575$kg/m

よって，負荷係数　$q_1=W_o/W_c$

$=0.575/0.235=2.447$

3．5　強度計算

電線単位長・単位切断面積当りの重量（δ）

$\delta=W_c/S_o$

$=0.235/67.3=0.003492$kg/m-mm²

最大使用張力　　600kg

安全率　　　　1,960/600=3.3＞3

単位切断面積当りの最大使用張力（f_1）

$f_1=600/67.3=8.92$kg/mm²

よって，$k=f_1-\dfrac{(q_1\delta)^2S^2E}{24f_1{}^2}$

$$=8.92-\frac{(2.447\times0.003492)^2\times S^2\times8,400}{24\times8.92^2}$$

又，$M=\frac{(q_2\delta)^2S^2E}{24}$

$$=\frac{(1\times0.003492)^2\times S^2\times8,400}{24}$$

更に，温度差（t℃）＝70－0＝70℃であるので，

∴ $\alpha tE=18.9\times10^{-6}\times70\times8,400=11.11$

又，$f_2^2\{f_2-(K-\alpha tE)\}=M$ よりf_2を求める。

弛度（D）＝$\delta q_2S^2/8f_2$

$=0.003492\times1\times S^2/8\times f_2$ (m)

その時の架線張力（T）＝f_2S

$=f_2\times67.3$ (kg)

電線実長（L_o）＝$S\{1+\frac{8}{3}(\frac{D}{S})^2\}$ (m)

以上の計算を整理すると各Spanに対する夫々の値は次のようになる。

Span（S）：	(m)	70	80	90	100	110	120	130
K：$=f_1-\frac{(q_1\delta)^2S^2E}{24f_1^2}$		7.35	6.86	6.32	5.71	5.03	4.29	3.49
M：$=\frac{(q_2\delta)^2S^2E}{24}$		20.91	27.31	34.57	42.68	51.64	61.46	72.13
$K-\alpha tE$		-3.76	-4.25	-4.79	-5.4	-6.08	-6.82	-7.62
f_2：$f_2^2\{f_2-(K-\alpha tE)\}=M$		1.92	2.08	2.22	2.35	2.46	2.56	2.65
D：$=\frac{\delta q_2S^2}{8f_2}$	(m)	1.11	1.34	1.59	1.86	2.15	2.46	2.78
T：$=f_2\cdot S$	(kg)	129	140	149	158	166	172	178
L_o：$=S\{1+\frac{8}{3}(\frac{D}{S})^2\}$	(m)	70.04	80.04	90.05	100.05	110.05	120.05	130.05

添付資料(5)　Project Part関連既設系統図

1. Project Part 1 関係

Fig. A.6.(5).1 : Kumasi 33kV Netwark 1988

Fig. A.6.(5).2 : Schematic Diagram of Bekwai 11kV Distribution

2. Project Part 2 関係

Fig. A.6.(5).3 : Accra/Tema Netwark Study

Fig. A.6.(5).4 : Tokuse Substation Single Line Diagram

3. Project Part 3 関係

Fig. A.6.(5).5 : Schematic Diagram of 33/11kV Substation "A" Sekondi/Takoradi

Fig. A.6.(5).6 : Schematic Diagram of 33kV O/H Line from Sekondi to Daboase

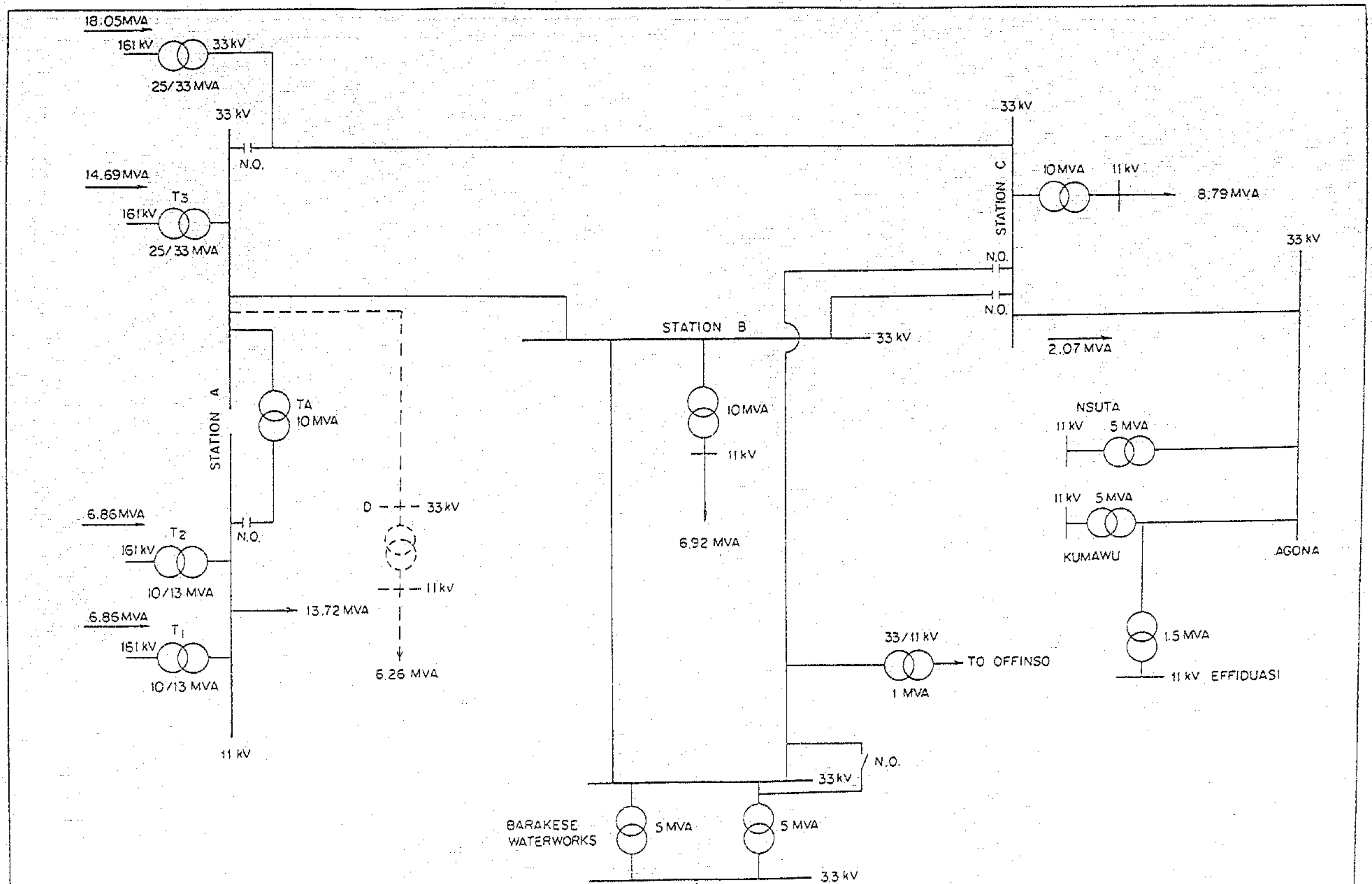


Fig.A.6.(5).1
KUMASI 33kV NETWORK 1988

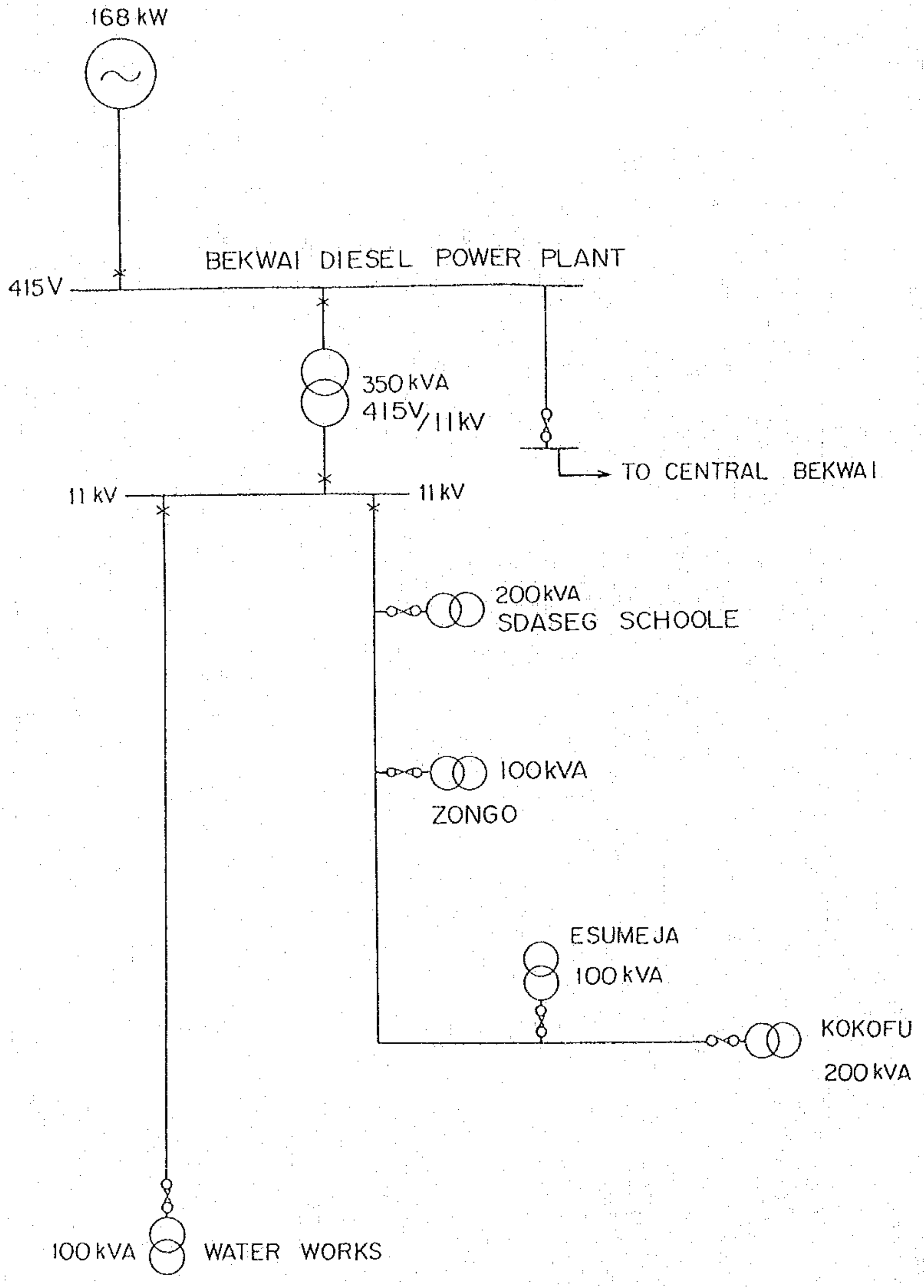


Fig. A.6.(5).2
SCHEMATIC DIAGRAM OF BEKWAI 11kV DISTRIBUTION

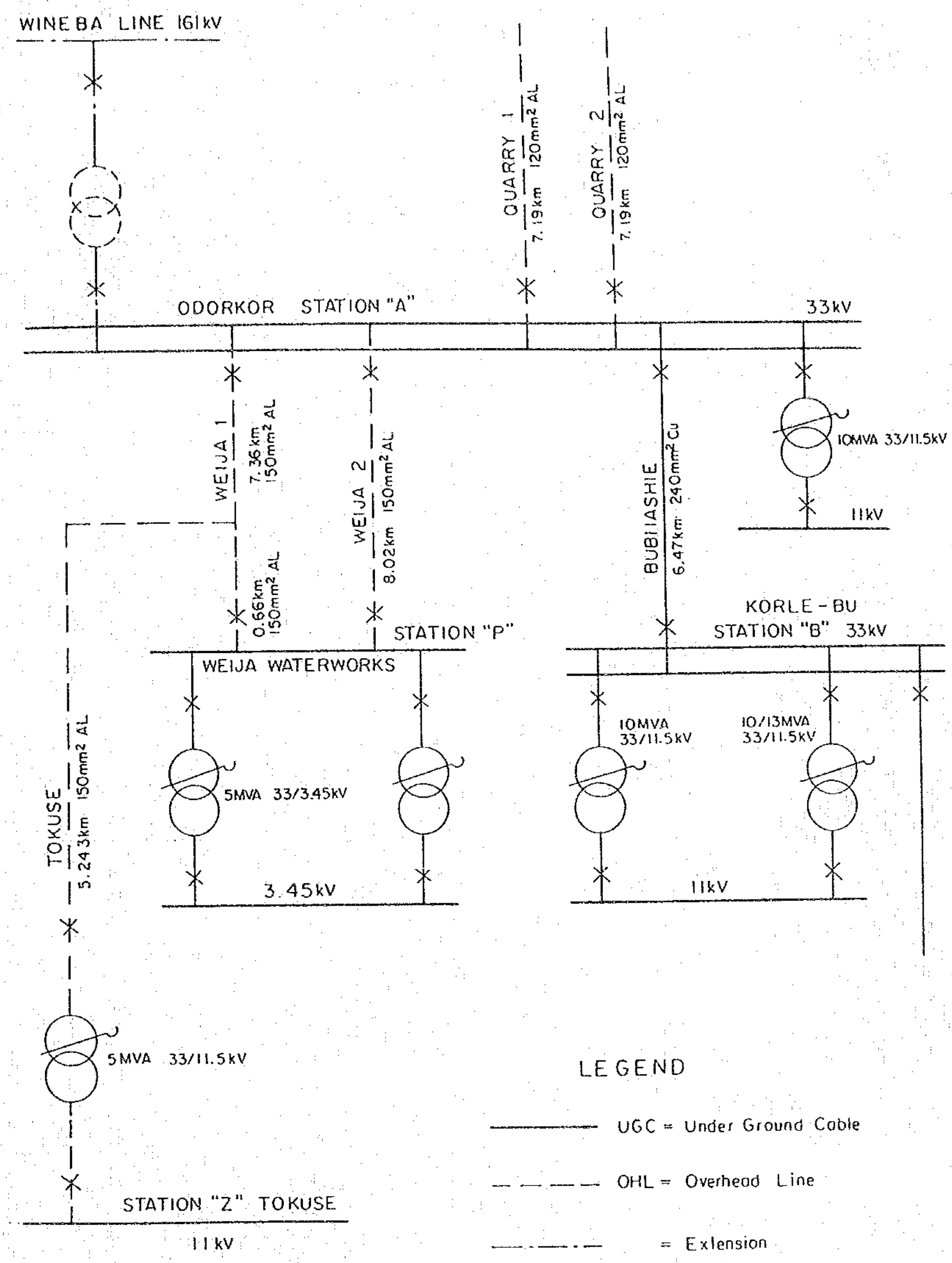
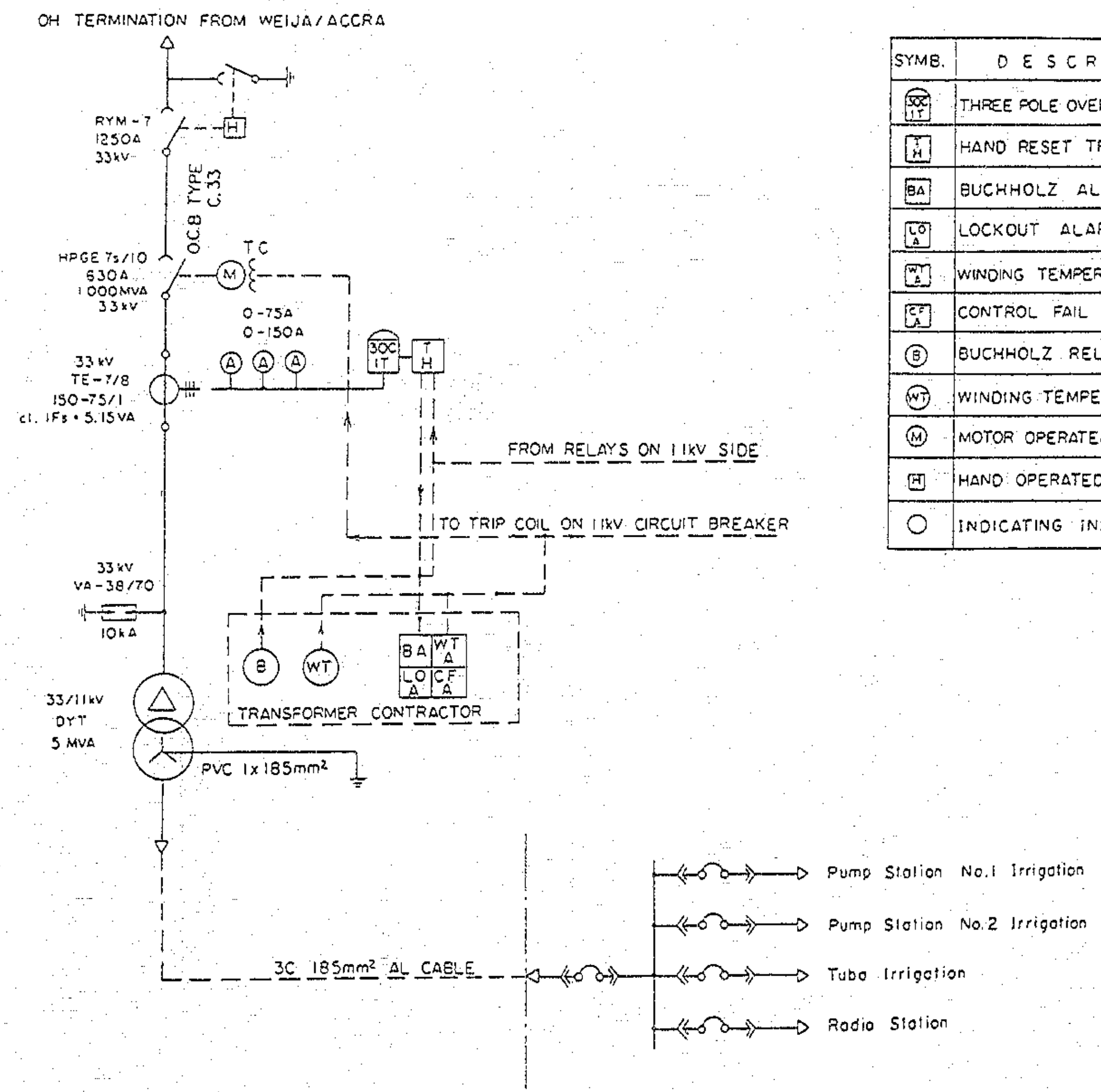


Fig. A.6.(5).3
ACCRA/TEMA NETWORK STUDY



SYMB.	DESCRIPTION	MAKER AND TYPE	REMARKS
30C IT	THREE POLE OVERCURRENT RELAY	"GEC" CDG 31	
T H	HAND RESET TRIP RELAY	"GEC" VAJY 11	
BA	BUCHHOLZ ALARM		
LO A	LOCKOUT ALARM		
WT A	WINDING TEMPERATURE ALARM		
CF A	CONTROL FAIL ALARM		
(B)	BUCHHOLZ RELAY	OTHER CONTRACT	
(WT)	WINDING TEMPERATURE	"	
(M)	MOTOR OPERATED APPARATUS		
H	HAND OPERATED APPARATUS		
○	INDICATING INSTRUMENT		

Fig.A.6.(5).4
TOKUSE SUBSTATION
SINGLE LINE DIAGRAM

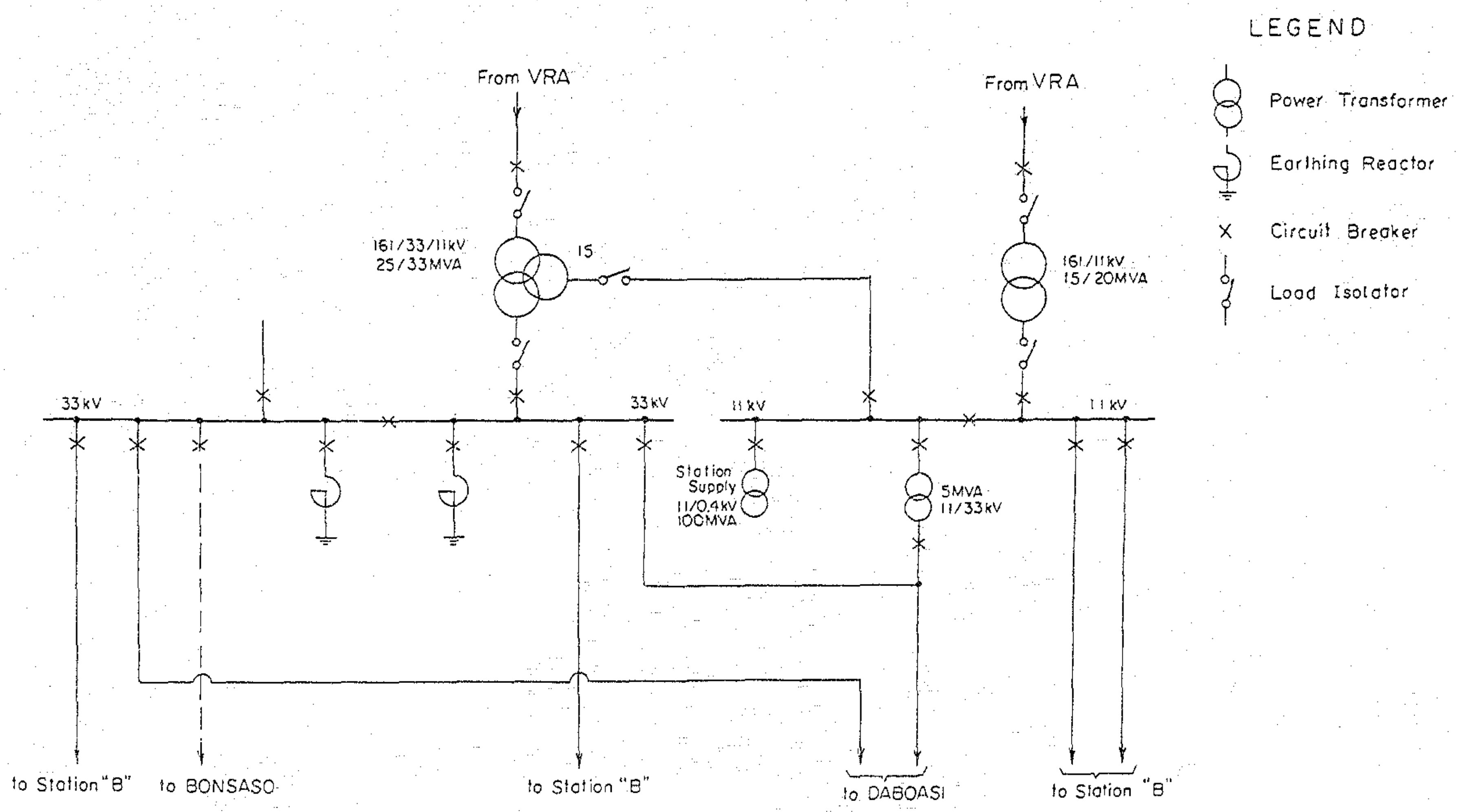
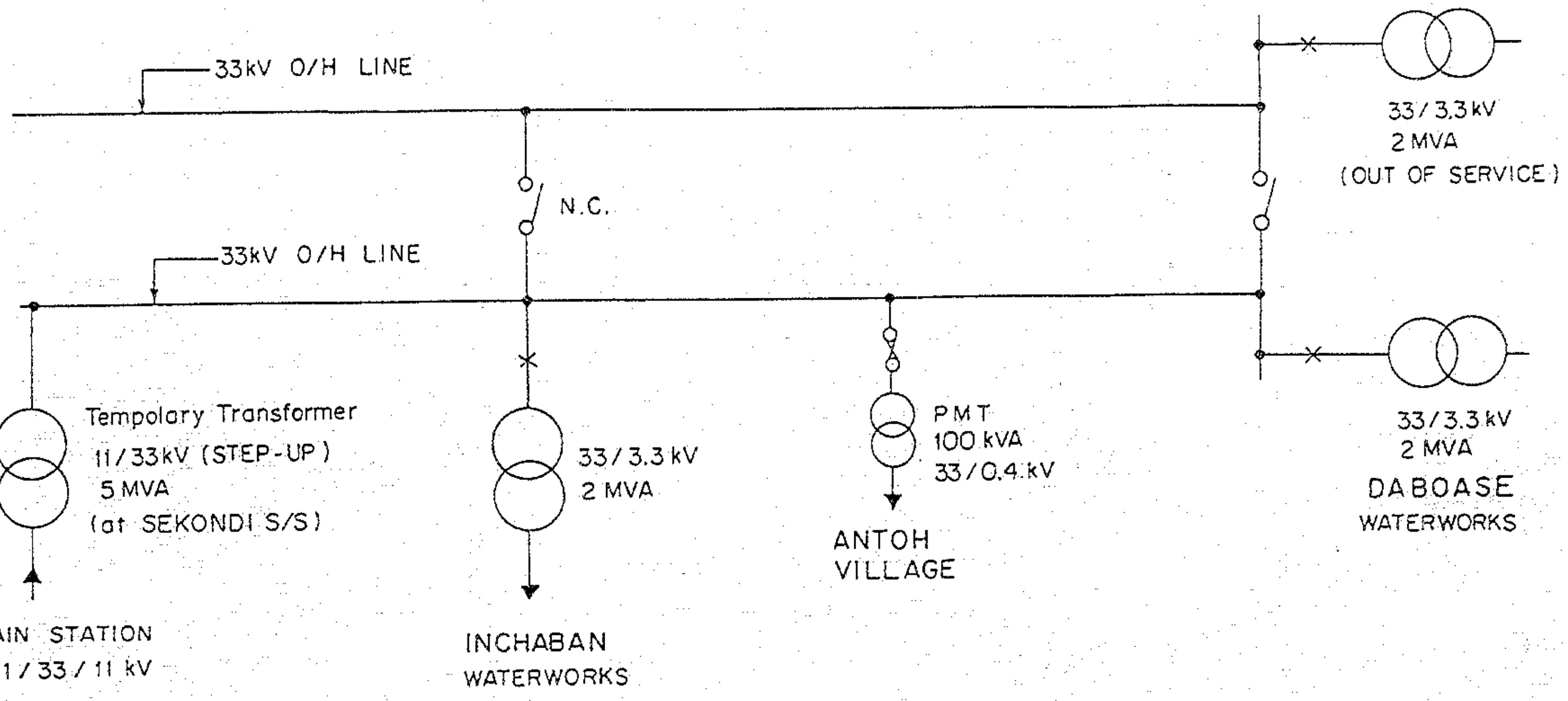


Fig. A.6.(5).5
SCHEMATIC DIAGRAM OF 33/11kV
SUBSTATION "A" SEKONDI/TAKORADI

Fig. A.6.(5).6
SCHEMATIC DIAGRAM OF 33kV O/H LINE
FROM SEKONDI TO DABOASE



JICA