Such phase to ground value is computed as follows:

$$\frac{550}{\sqrt{3}} \times (1.22 + \alpha) = 419 \text{ kV } (\alpha = 0.1)$$

Therefore, the rated voltage of arresters as determined shall be 444 kV, a little higher than 419 kV.

The recent arrester, for instance, metal oxide type, rated at 444 kV has the following capability:

The maximum discharge voltage for lightning impulse at the lightning discharge current 10kA (8 x 20 μs) is 1,069 kV. Although switching impulse discharge voltage is not specified, it is inferred to be approximately 900 kV or below because of limit voltage at the lightning discharge current of 1.5 kA (8 x 20 μs).

From the above-mentioned characteristics of arrester performance, the rated lightning (switching) impulse withstand voltage of the equipment can be determined as follows:

For lightning impulse	1,550 kV
For switching surge	1,175 kV

Insulation coordination of EHV substations in the Philippines is shown on Fig. 6-2.

6.2.2. Bus Clearance

Following standard dimensions of bus clearances are recommended.

Phase to phase	-	8 m
Height of ground part	-	25 m (minimum)
Live part height	-	7 m (minimum)
Bus bar	-	18 m
Branch bus bar	-	29 m
Overhead ground wire	-	36 m

The details of above clearances are shown on Figs. 6-3 & 6-4. Fig.6-3 shows a conventional type, applicable to all substations except Gened. Fig.6-4 is a hybrid type to be applied only for Gened.

6.2.3. Contamination-proof Design

The contamination-proof design for substation (suspension, station post insulator and bushing) is conducted on the basis of IEC Recommendation "Guide for the Choice of Insulation under Polluted Condition (1980)", as shown on following table:

Substation	Distance from Seacoast (km)	Design Level to be Recommended	Leakage Distance, Phase to Phase (kV)
Gened	35	Light	16 mm
Solano	More than 50	Light	16 mm
San Jose	20	Light	16 mm
Kalayaan	20	Light	16 mm
Naga	15	Medium	20 mm
Legaspi	2	Medium	20 mm

Following tables shows the maximum required number of insulators as determined on necessary leakage distance and from lightning impulse and switching surges shown on Figs.6-5 and 6-6.

Design Level	Leakage distance (mm)/(kV)	Leakage distance (mm) at 550 kV	No. of Insulators		Lightning impulse voltage kV
Light	16	8,800	St Sm	31 21	1,550
Medium	20	11,000	St Sm	38 28	1,550

Design Level	No. of Insulators by lightning impulse withstand voltage		Basic Switching surge voltage kV	No. of Insulators by switch surge withstand voltage		No. of Insulaters finally determined	
Light	St Sm	21 20	1175	St Sm	31 31	St	31
Medium	St Sm	21 20	1175	St Sm	31 31	Sm	31

Note: *1 Insulator (IEC standard)

St: CA-50/EC
disc. 254 mm, spacing 146 mm, leakage distance 292 mm
e/m falling load 12 ton

Sm: CA-825EC
disc 254mm, spacing 146 mm, leakage distance 432 mm
e/m falling load 12 ton

*2 Ref. Fig.6-5 Following factors being applied for 1550 kV.

(1) Correction factor for ambient condition 1.05.
(2) Ratio of withstand voltage to 50% flashover-voltage 1.12

$\therefore$ 1550kV x 1.05 x 1.12 = 1,823 kV.

*3 Ref. Fig.6-6 Following factors being applied for 1175 kV.

(1) Correction factor for ambient condition 1.05
(2) Ratio of withstand voltage to 50% flashover-voltage 1/0.85

$\therefore$ 1175 x 1.05 x 1/0.85 = 1,452 kV

6.3. Bus Connection System

Bus connection system for EHV substations in the Philippines was determined to be 1-1/2 circuit breakers system after comparative study of most popular four (4) systems.

The major reasons of this adoption are described below:

(1) It is not necessary to stop the operation of main transformers or transmission lines when circuit breakers are opened in order to do inspection or maintenance work.

(2) There would be no power supply interruption even if a fault occurs in bus.

The comparison of bus connections is mentioned in detail on Table 6-1.

6.4. Electrostatic Induction Problem

For prevention of electrostatic induction in the EHV substation yard, the maximum potential gradient shall be kept below 12 kv/m (the value measured at one (1) meter above the ground). This value was determined on the following basis:

The test results conducted by the Electric Power Research Institute in the United States are shown on Fig.6-7.

The following are the resume of the results.

The potential gradient beyond the torelance of the human body is of the values more than 15 - 20 kv/m.

The intensity of potential gradient that the human body begin to sense the electricity is generally above 10 - 15 kV/m though there are somewhat personal differences in degree.

As a result, the target values of potential gradient were set at 12 kV/m for substation yard which will not affect the human body, and 8 kV/m for the surroundings of substation.

From the experiences, following measures are required in order to keep the potential gradient below 12 kV/m.

(1) The minimum height of energized parts should be 7m or above.

(2) The minimum height of grounded part should be taken more than 2.5 m.

These values have been reflected to bus clearances.

6.5. Radio Interference and Bus Conductor

The frequencies of corona noise caused by EHV transmission lines and substations are more or less 1 MHZ, which will give interference to medium wave communication. Since the existing 230 kV system has not caused any particularly noticeable radio interferences, it was designed that the corona noise level of the EHV system should be kept equivalent to that of the 230 kV system.

In expressing the corona noise level, the intensity of electric field at 10 m below the charging component and 1 μV/m is regarded to equal to 0 db.

The corona noise level of 230 kV single 795 MCM conductor transmission line is 73.5 db (72.3 db) where conductor separation is 6 m (7 m).

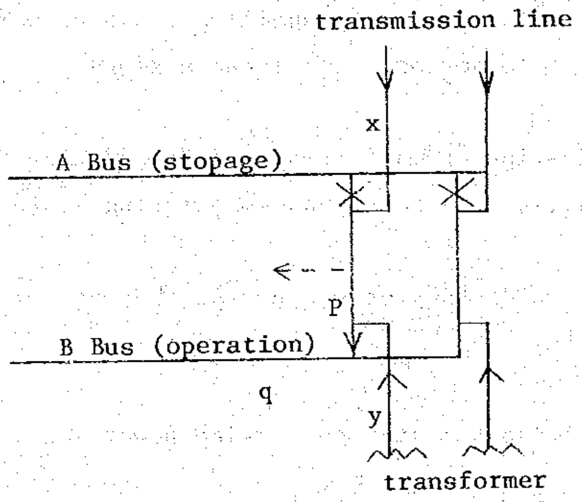
Assuming the noise level of EHV system at 70 db, conductors should have a sectional area of more than 660 mm^2 in the case of horizontally parallel 3 conductor arrangement. The relationship is drawn on Fig.6-8.

Subsequently, current capacity of conductor is examined with regard to this subject. Considering the following figure is of ordinary substation circuits and on the basic concept that operation is made at 70% of the current capacity of conductor which is here considered as 795 MCM x 4, the main bus is required to have a current capacity of approx. 5400A and branch bus to have a current capacity of approx. 2700A with one bus faulted.

The current capacity of each of horizontally parallel 3 conductor arrangement is given on Fig.6-9.

As shown on this figure, HA1 660mm^2 x 3 for branch bus and ThA1 850mm^2 x 3 for main bus shall be used.

Bus current carrying capacity



Note 1 Designed conductor size for transmission line is ACSR 795 MCM x 4. Normal carried current is assumed at 70% of maximum current carrying capacity, carried current at x point is 2370A (=835A x 4 x 0.7).

Note 2 Main transformer capacity is 300MVA and normal carried current at y point is as below:

$$\frac{300 \times 10^3}{\sqrt{3} \times 550} = 330A$$

Note 3 Carried current at p point 2340 + 330 = 2670A

Note 4 Carried current at q point 2670A x 2 = 5340A

Note 5 Consequently main bus is required to have the current carrying capacity of 5.4 kA, and branch bus to have the same value of 2.7 kA.

6.6. Reliability Improvement Measures

Major items considered for improvement of reliability of EHV system are as follows:

(1) Two (2) cycle interruption time circuit breaker shall be applied and reclosing scheme is applicable.

(2) Main protective relay shall be designed with solid-state circuit to perform high speed action.

(3) Duplication of main relay system and adoption of automatic inspection and continuous monitoring system.

(4) Adoption of back-up system for the case of circuit breaker failure.

(5) Duplication of station service power source.

(6) Keeping proper quantities of spares and accessories.

Table 6-2 indicates the objective portions for duplicated system.

6.7. Control and Protective Scheme

6.7.1. Control System

Continuous supervisory control system will be applied. Automatic and/or manual control system by one operator is recommended. (same system as existing 230 kV substation).

New control room will be constructed for EHV equipment control except Gened, Kalayaan, cases.

6.7.2. Protection Scheme

(1) Transmission Line Protection

(a) Primary protection will be duplicated and its operation time shall be within two (2) cycles.

(b) Phase comparison scheme is composite sequency quantities ($KI_0 - I_1$) and sliced level type.

(c) I ϕ/3ϕ high speed reclosing and/or low speed reclosing are available.

(d) Power line carrier (PLC) terminals are associated.

(e) Overall automatic inspection/continuous monitoring devices are associated.

(f) Back-up protection will be directional impedance relay (lens shape characteristics with blinder) type and over current relay is associated and continuous monitoring devices are incorporated.

(2) Bus Protection

(a) Primary relay is differential voltage relay and fail safe relay is voltage relay and solid-state type.

(b) Overall automatic inspection/continuous monitoring devices are associated.

(3) Transformer Protection

(a) Ratio differential relay incorporated with high speed over current relay is associated.
(b) Back-up protection will be over current and over voltage ground relays.
(c) Overall automatic inspection/continuous monitoring devices are associated.

(4) Anti circuit breaker failure device

Sequence controller with time limit of 12 cycles are applied.

(5) Shunt Reactor Protection

Differential relay and overcurrent relay are associated.

(6) Fault Locator and Others

(a) Surge receiving type fault locator for transmission line faults will be applied. Base terminal signal transmitting devices and satellite terminal signal receiving devices are considered.
(b) Tele-communication system:

Tele-communication channels for 500kV protective relay will be duplicated with power line carrier (PLC), and for supervisory control such as telex, telemetering and telephone will be two (2) channels with PLC or micro wave. This design policy is shown on Fig. 6-10.

(7) Data to be dispatched to Luzon Grid Control Center

Compatible communication, data-acquisition and control facilities in the EHV transmission system will be considered.

The details of protection system of EHV substation are shown on Fig.6-11, and model station service circuits are shown on Fig.6-12.

6.8. Consideration of Environmental Impact

Mainly the countermeasures for the fire protection are considered.

(1) Against the oil spilling from the main transformers and shunt reactors, ballast laying of 0.5 - 1.0 meter depth surrounding their foundations will be required.

(2) For main transformers, fire segregating concrete wall and both automatic and manual fire extinguisher of water supply will be provided, and for shunt reactors, fire extinguishing water taps of manual control will be required.

6.9. Seismic and Wind Condition

Maximum actual wind velocity of 185 kPH will be applied as same as that of existing substations. Seismic condition will be applied 0.3 G static, because the EHV equipment height are more than seven (7) meter.

6.10. Grounding Design

Grounding basic calculation will be conducted on the basis of stipulation given in the standard "Guide for Safety in A.C. Substation Grounding, IEEE Standard, 80-1976".

Selection of grounding wire and jointing materials; conductor sizes are HDCC 100-150 mm^2 for main mesh, HDCC 100 mm^2 for lead from equipment and HDCC 38 mm^2 for lead from equipment which is only necessary to keep zero potential. Embedded connection will be of compression type or welded type. For equipment or structure connection, bolted type will be used.

Higher steel structures with overhead ground wires will be equipped with lightning rods which are connected to the earth through insulated and/or HDCC 100 to 150 mm^2.

6.11. Main Equipment in EHV Substation

6.11.1. Main Transformer

(1) Based on experience there are varied conditions in the landing ports and roads, it is therefore recommended that the transportation limits for the Gened and Solano stations will be as follows:

(size) 3.5m width, 5 - 6m length, and 4.0 m height including trailer.

(weight) 40 ton (transformer only)
And, for Kalayaan and San Jose substations, the limitation of size is the same as above, but the weight of transformer will be 60 ton.

(2) The capacity of main transformer is specified as follows:

ONAN	300 MVA x 60%
OFAF 50%	300 MVA x 80%
OFAF 100%	300 MVA x 100%

(3) On-load-tap-changer and stabilizer winding of 30% transformer capacity shall be provided to the main transformer.

6.11.2. Shunt Reactor

(1) Shunt reactors will be designed as same as transformer concerning transportation conditions.

(2) Unit capacity and cooling system of shunt reactor will be designed as follows:

	525 - 230 kV	69 kV
Unit capacity	70 MVAR	35 MVAR
Cooling system	100% OFAF	100% OFAF

6.11.3. Circuit Breaker

(1) Nominal voltage 500 kV

(2) Rated maximum voltage 550 kV

(3) Rated current 3000 A

(4) Short-circuit breaking current 40 kA
(IEC 56-1971 TAble XIII)

(5) Rated transient recovery voltage for terminal faults

100%	RRRV	2 kV/us
60%	RRRV	3 kV/us
30%	RRRV	5 kV/us
10%	RRRV	10 kV/us

(6) Rated Operating Sequence

O - t - CO - t' - CO for transmission line
CO - t" - CO for transformer, shunt reactor

(7) Maximum Permissible Switching Overvoltage
858 kV

(8) Type
Gas circuit breaker

6.12. Substation Site and Equipment Layout

The Project includes four (4) stations, namely, Gened, Solano, San Jose and Kalayaan.

6.12.1. Gened Hydro Power Sation

The Gened Hydro Power Station will be the northern end of the EHV system in Luzon. The output of this power station (600 MW) will be transmitted finally to Manila via Solano through the EHV transmission line. This power station will also have 230 kV switching equipment that will be connected to Santiago via Ballesteros, Lallo and Tuguegarao. The Gened Hydro Power Project is stated in detail in the reports entitled "Apayao-Abulug River Hydroelectric Development Project". The EHV transmission project under this study covers only the EHV portion of the Gened Project. Accordingly, two (2) circuits of 500 kV transmission line including associated steel structures, bus bars, control cables, protective devices, bus protection system, etc. are considered within the scope of this Project. Because of the limited availability of switch-yard at the site, hybrid scheme was adopted.

6.12.2. Solano Substation

In the Luzon power system, Solano substation will be a key substation, at which the outputs of Magat, Chico IV, Diduyon and CFTH-III would be linked in future and stepped up to EHV for sending these power to San Jose substation. This substation will have four 230 kV circuits in 1982, however the adjacent land area of about 120,000 m^2 will be purchased for future extension. Finally, this substation is expected to have installations of 500 kV x 4 circuits, main transformer x 4 banks, shunt reactor 700 MVAR and 230 kV x 10 bays.

The scope of this Project is composed of:

500 kV transmission line	4 circuits
500/230 kV main transformer	2 banks
Shunt reactor	700 MVAR

The circuit arrangement and equipment layout were proposed on Fig. 6-14 and 6-15.

6.12.3. San Jose Substation

San Jose Substation is a key substation which receives hydro power in northern Luzon, interconnection with Bataan Thermal and Philippine Nuclear Power Stations as well as supply of power to the Metro Manila area.

At present, the substation has 230 kV x 6 circuits, 115 kV x 6 circuits and 230 kV/115 kV transformer 300 MVA x 2. A part of the EHV substation site has been already acquired. The final plan of this substation is composed of 500 kV x 4 circuits main transformer 300 MVA x 6 banks, 230 kV system x 7 bays, 115 kV system x 6 bays and shunt reactors 210 MVAR.

The scope of the Project in this study includes:

500 kV transmission line	2 circuits
500/230 kV main transformer	1 bank
500/115 kV main transformer	1 bank
Shunt reactor	210 MVAR

Figs. 6-16 and 6-17 show the circuit arrangement and equipment layout of this substation.

6.12.4. Kalayaan Substation

Kalayaan substation site is located about 5 km away from the Kalayaan power station which is the first pumped storage type plant.

This substation will receive the power of the above-mentioned pumped station and of geothermal generating units in Southern Luzon to supply the demand in and around Metro Manila. Final installation planned for Kalayaan will be consisted of 500 kV x 4 circuits, main transformer x 4 banks, shunt reactor x 560 MVAR and 230 kV x 8 bays. Eight (8)bays of 230 kV includes the transfer of 230 kV x 6 circuits which are at first installed at the switchyard of the Kalayaan Pumped Power Station.

The Project scope considered in this study is as follows:

500 kV/230 kV main transformer	1 bank
230 kV bus bar arrangement	for 6 circuits

The circuit diagram and layout of the equipment are shown on Figs. 6-18 and 6-19.

Table 6-1 Comparison of Each Bus Configurations

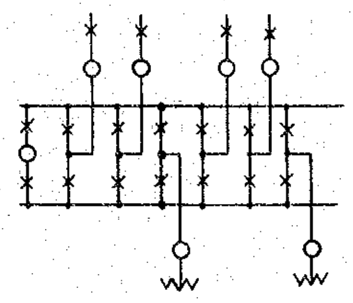
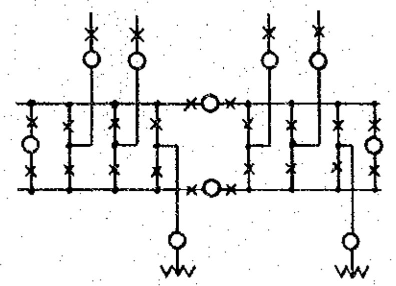
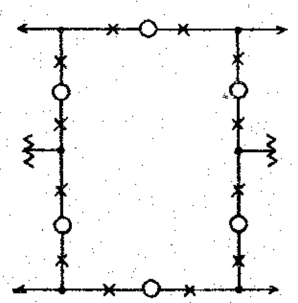
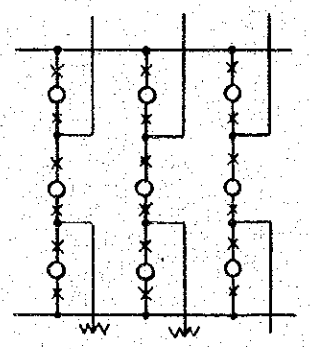
Configurations	One line diagram Legend o Circuit breaker (C.B.) x Disconnecting switch (D.S.) Main transformer	Nos. of circuit breakers and disconnecting switch	Outage requirement for circuit breaker maintenance	Problem involved in substation operation	Service stoppage in case of bus fault
Double bus bar, single tie line bus configuration		CB 7 DS 18	Outage required	No problem	Function of system connected to the bus being halved
Double bus bar, four divided bus configuration		CB 10 DS 24	ditto	ditto	Function being cut to 3/4
Ring bus bar Configuration		CB 6 DS 12	Outage not required	System separation, apt to be incurred in case of outage of a transformer or transmission line under the C.B. maintenance.	Service outage will be incurred on the main transformer or transmission line connected to the faulted bus bar
1½ C.B. bus bar configuration Preferable configuration for Luzon EHV substation		CB 9 DS 18	ditto	No problem	No effect

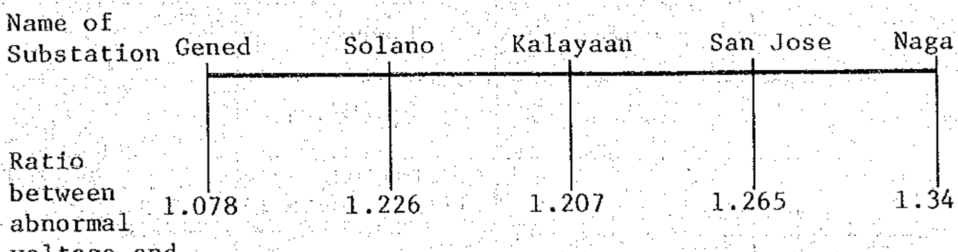
Table 6-2

Duplicated Facilities in Philippine EHV Substation

(Comparing with existing substation)

Item		existing 230 kV substation	Proposed plan for EHV Substation	Note
Main Trans-former	Protective relay	(M+B)x 1	Transformer only (M+B)x1, Including bus protecion(M+B)x1	M: Main relay B: Back up relay
	Electric source for cooler	1 route	2 routes	
Circuit breaker	Oil pump	single	duplicate	
	Others	-	C.B.failure relay will be installed.	
Protection relay	Line protection	(M+B) x 1	M x 2 + B x 1	
	Tele-communication route for line protection	single	duplicate	
	Bus protection	single	single	
	CB.failure relay	-	single	
	Fault locator	-	single	
	Automatic Oscillograph	-	single	
Station service	Station source transformer	single	duplicate (including power supply route)	
	Home service transformer	single	ditto	
	Battery charger 125V	duplicate	duplicate	
	Battery charger 48V	single	duplicate	
Telephone and Others	Telephone	2 channels	2 channels	
	Remote control Telex Tele-metering	2 channels	2 channels	

Fig. 6-1 Sound Line Abnormal Voltage Rise in Case of Other One Line Ground Fault



Note 1. Ratio between abnormal voltage and highest voltage for equipment is indicated as above value x $\frac{500}{550}$, such as Naga case 1.34 x $\frac{500}{550}$ = 1.22.

2. These values are conducted by CPU. The following figure indicates the case of 1ϕ ground fault at Naga substation bus.

(EX.)

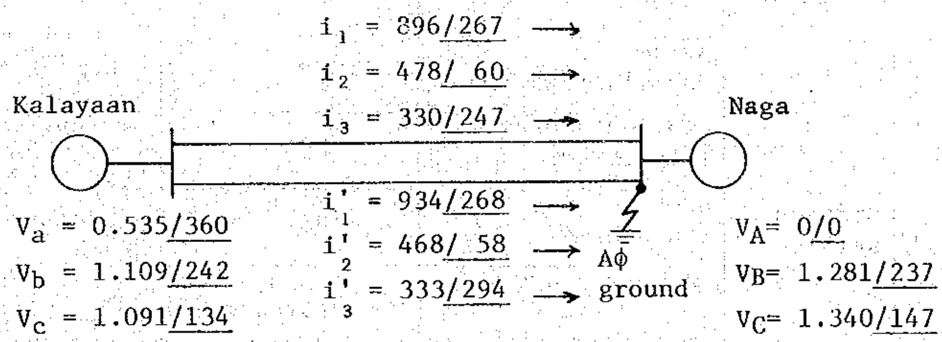
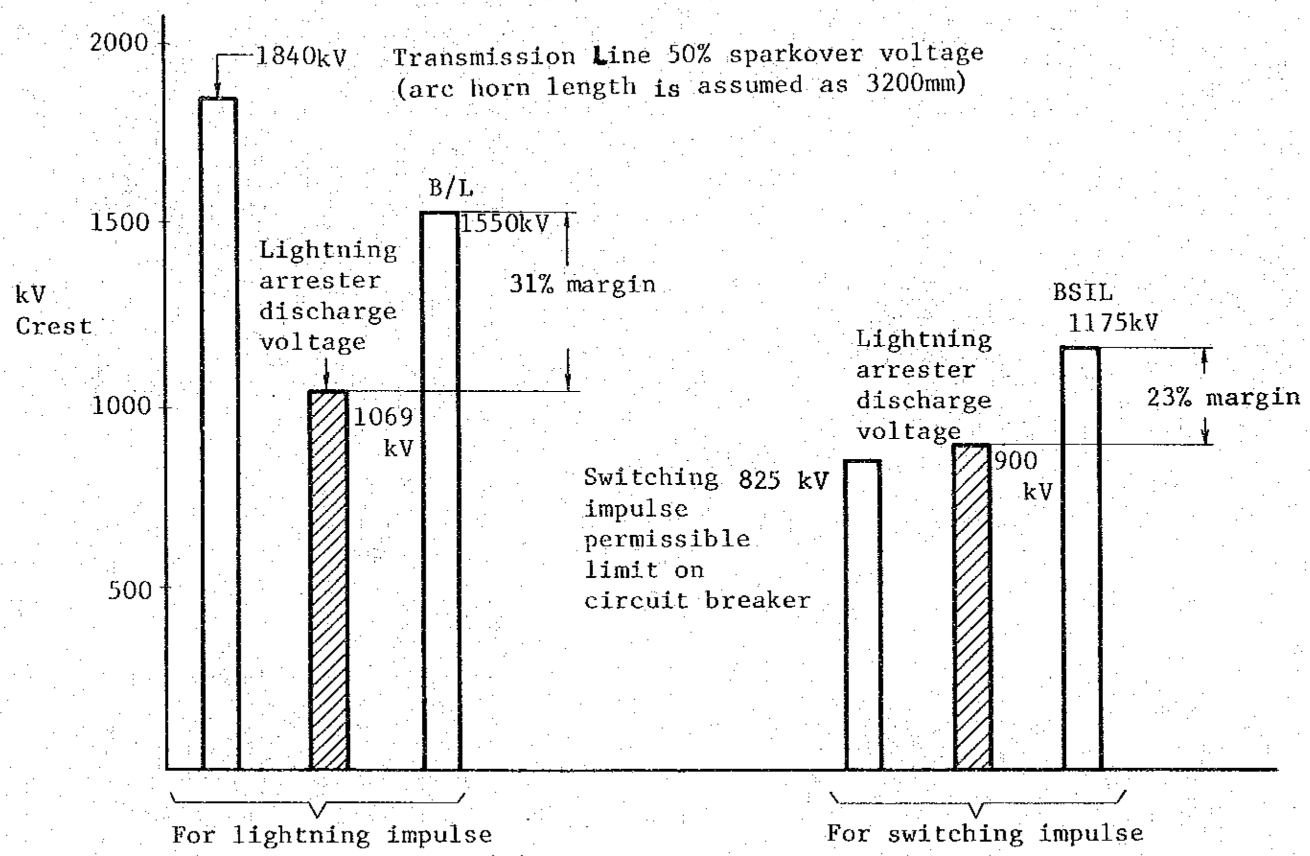


Fig. 6-2 Insulation Coordination



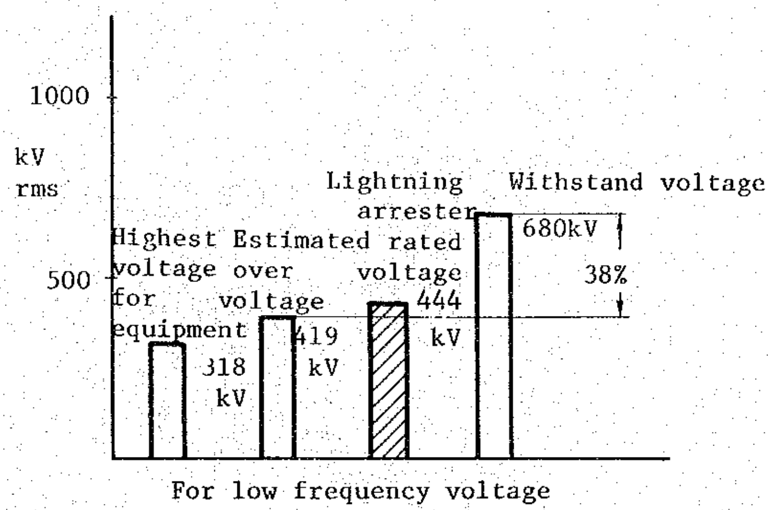
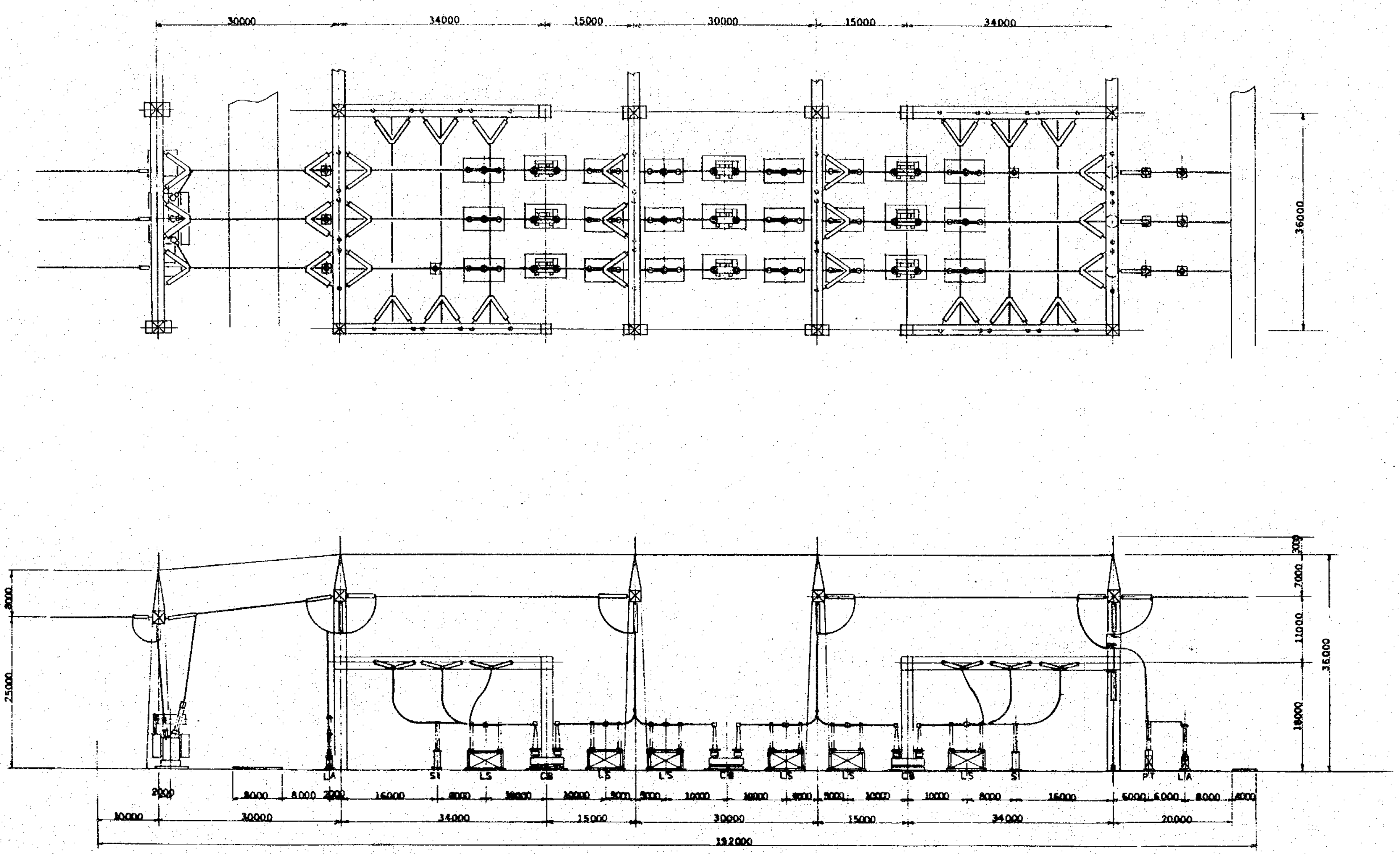
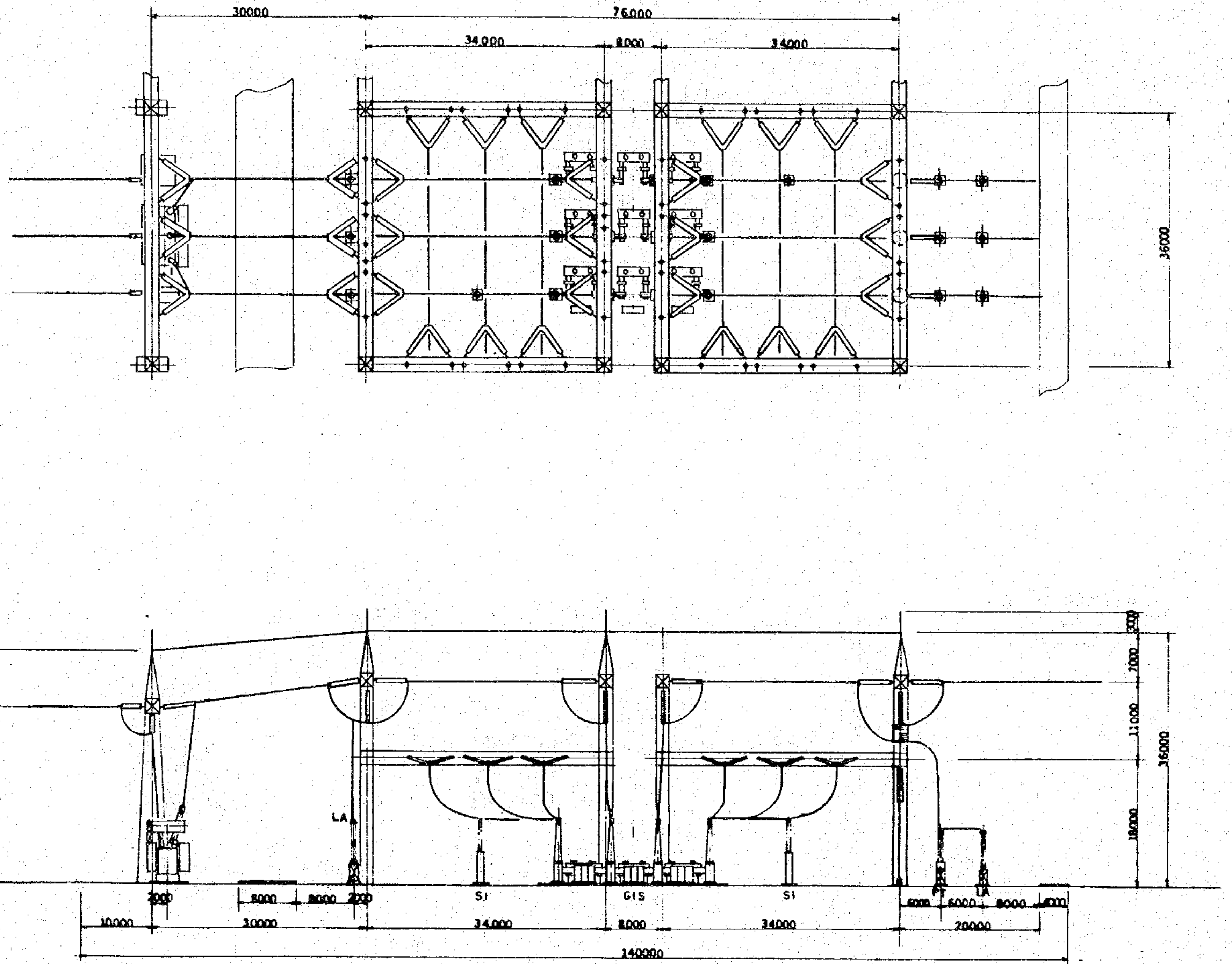


Fig. 6-3 Conventional Type Layout
(Dead Tank Gas Circuit Breaker)



legend			
T R	transformer	C B	circuit breaker
CUB	cubicle	L T	line trap
S I	supporting insulator	P T	potential transformer
L S	line switch	L A	lightning arrester

Fig.6-4 Hybrid Type Layout



legend			
T R	transformer	L T	line trap
CUB	cubicle	P T	Potential transformer
S I	supporting insulator	L A	lightning arrester
G I S	gas insulated switchgear		

Fig. 6-5 Impulse (positive) 50% Flashover Voltage Characteristic of Suspension Insulator

(Cited from N.G.K. Technical Catalog)

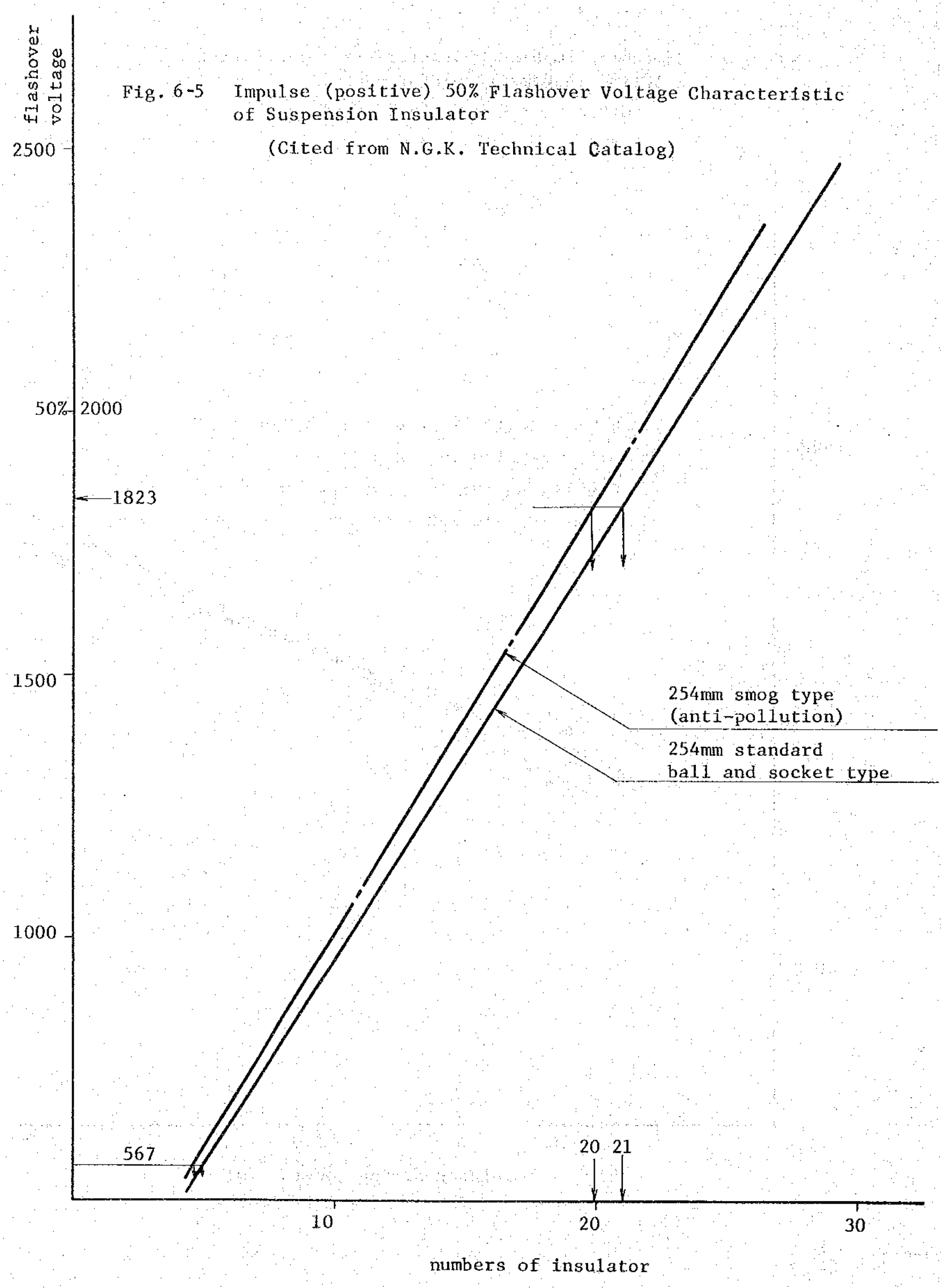


Fig. 6-6 Switching Impulse Characteristic of Suspension & Anti-Pollution Insulator

(Cited from N.G.K. test data)

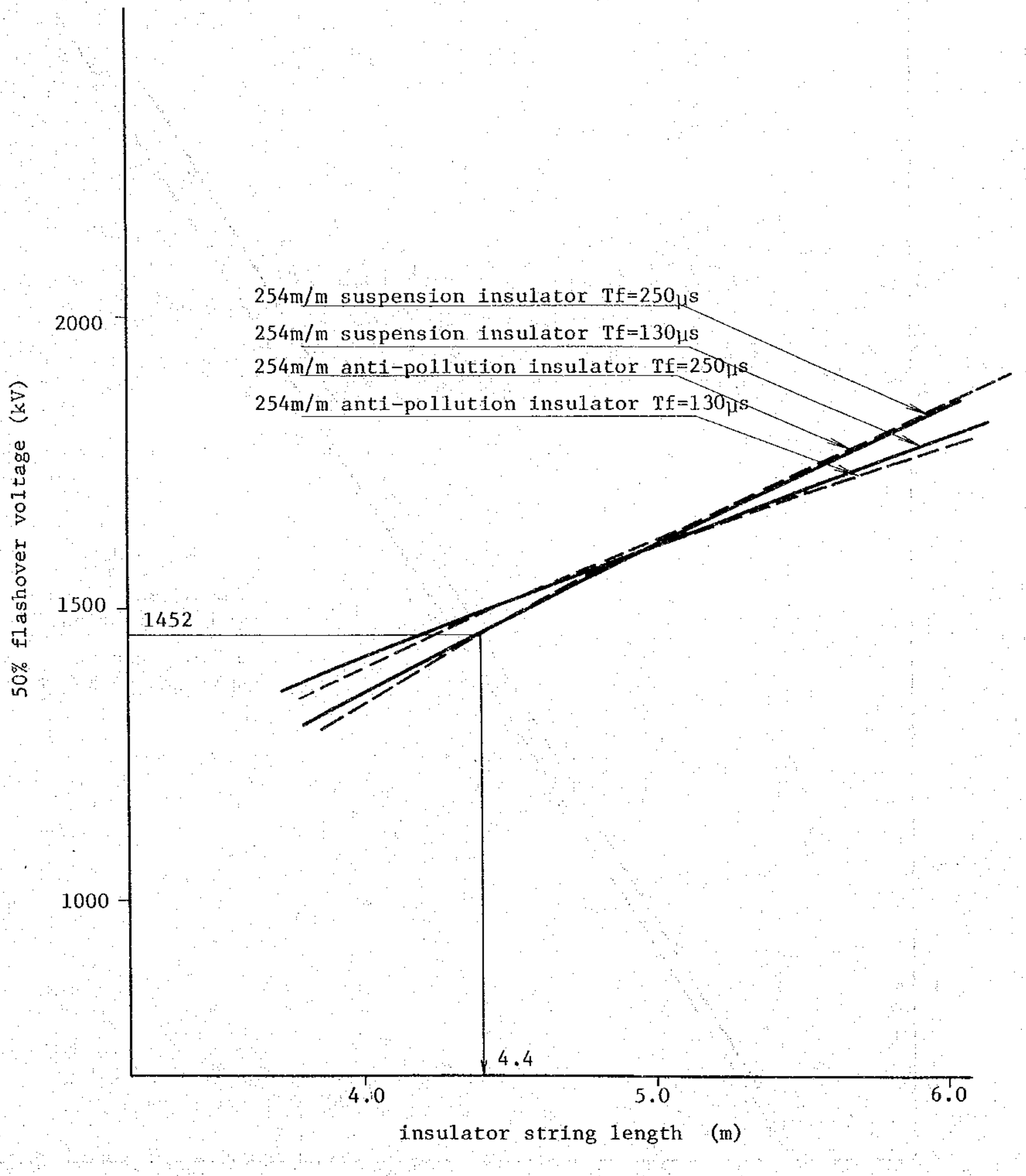
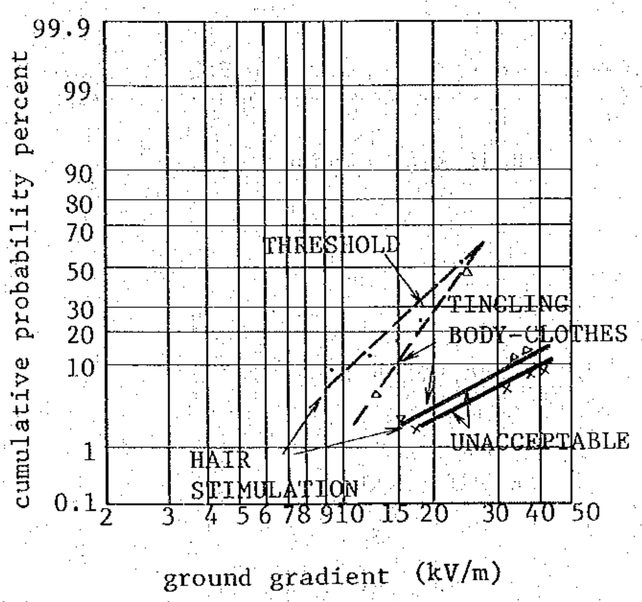


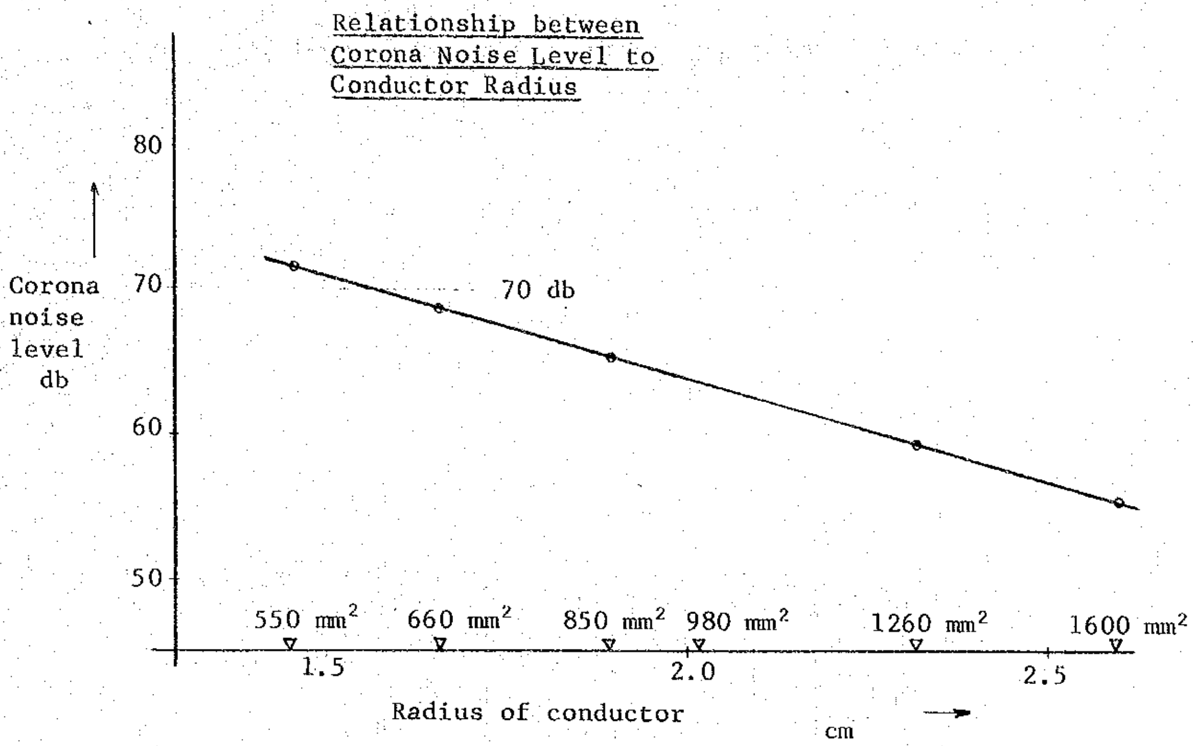
Fig. 6-7 Effect of Gradient at Ground Level on Persons



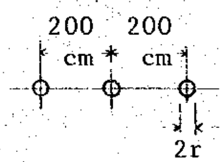
27 people, some of them on different occasions were asked to walk under the test line and to fill out a analysis of the answers showed the figure.

Fig. 6-8

Relationship between Corona Noise Level to Conductor Radius



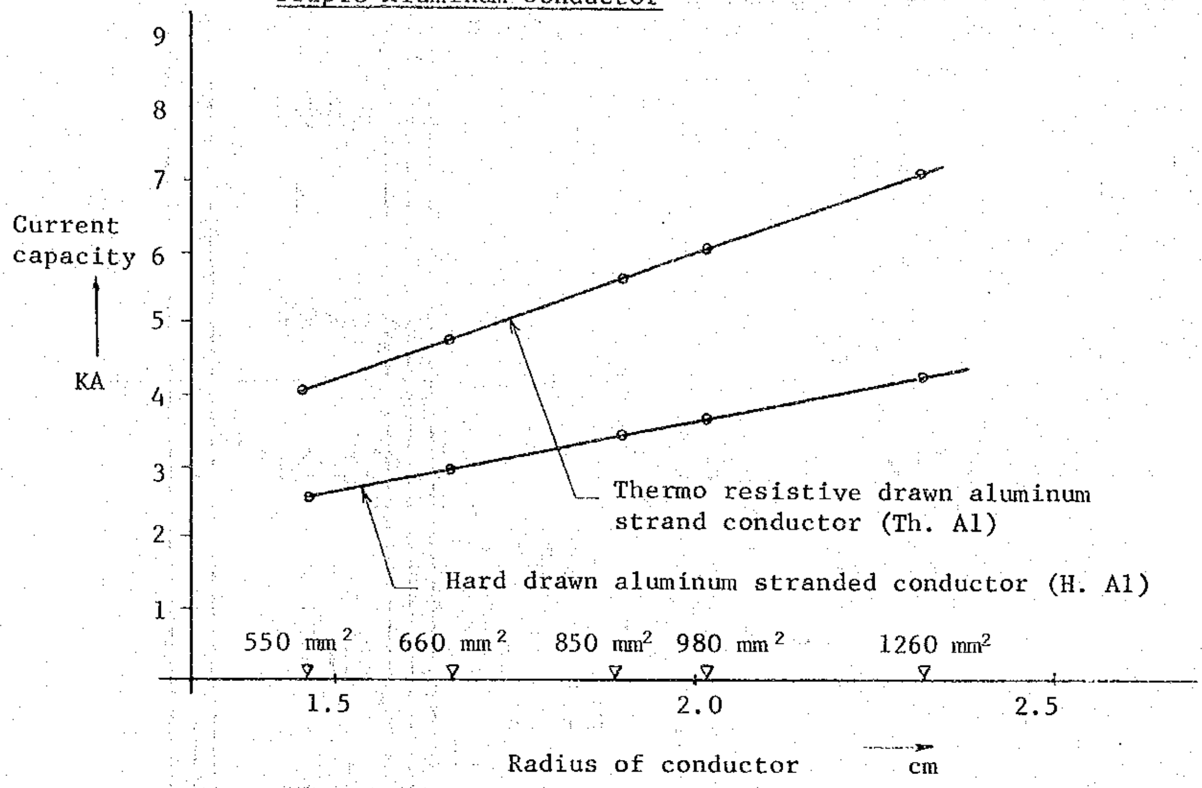
Bus conductor arrangement



r: Radius of conductor

Fig. 6-9

Current Capacity of Horizontally Stringed Triple Aluminum Conductor



Note 1. Bus conductor arrangement is same as Fig. 6-8

2. Condition

Conductor temperature

Th. Al; 150°C
H. Al; 90°C

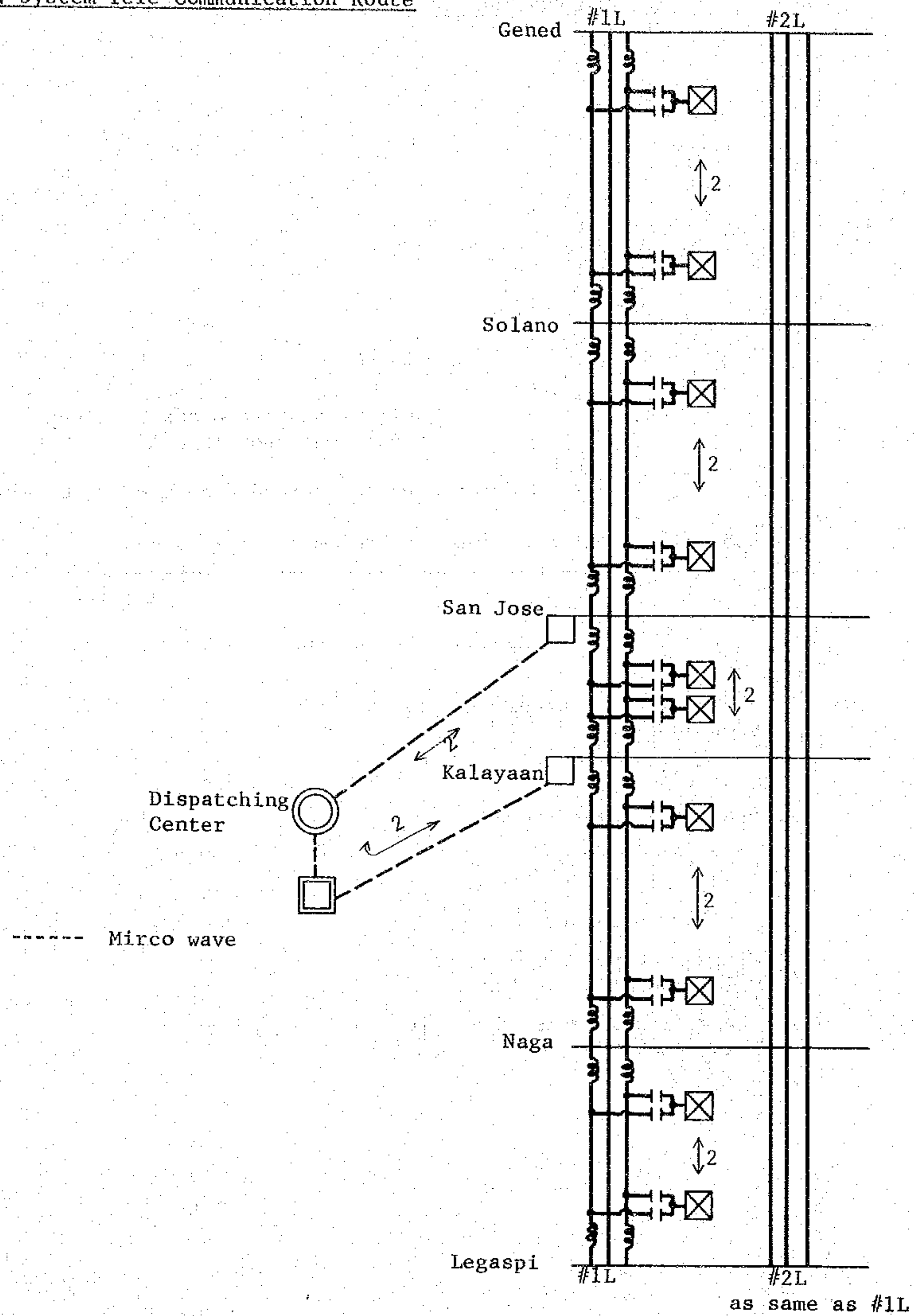
Ambient temperature 40°C

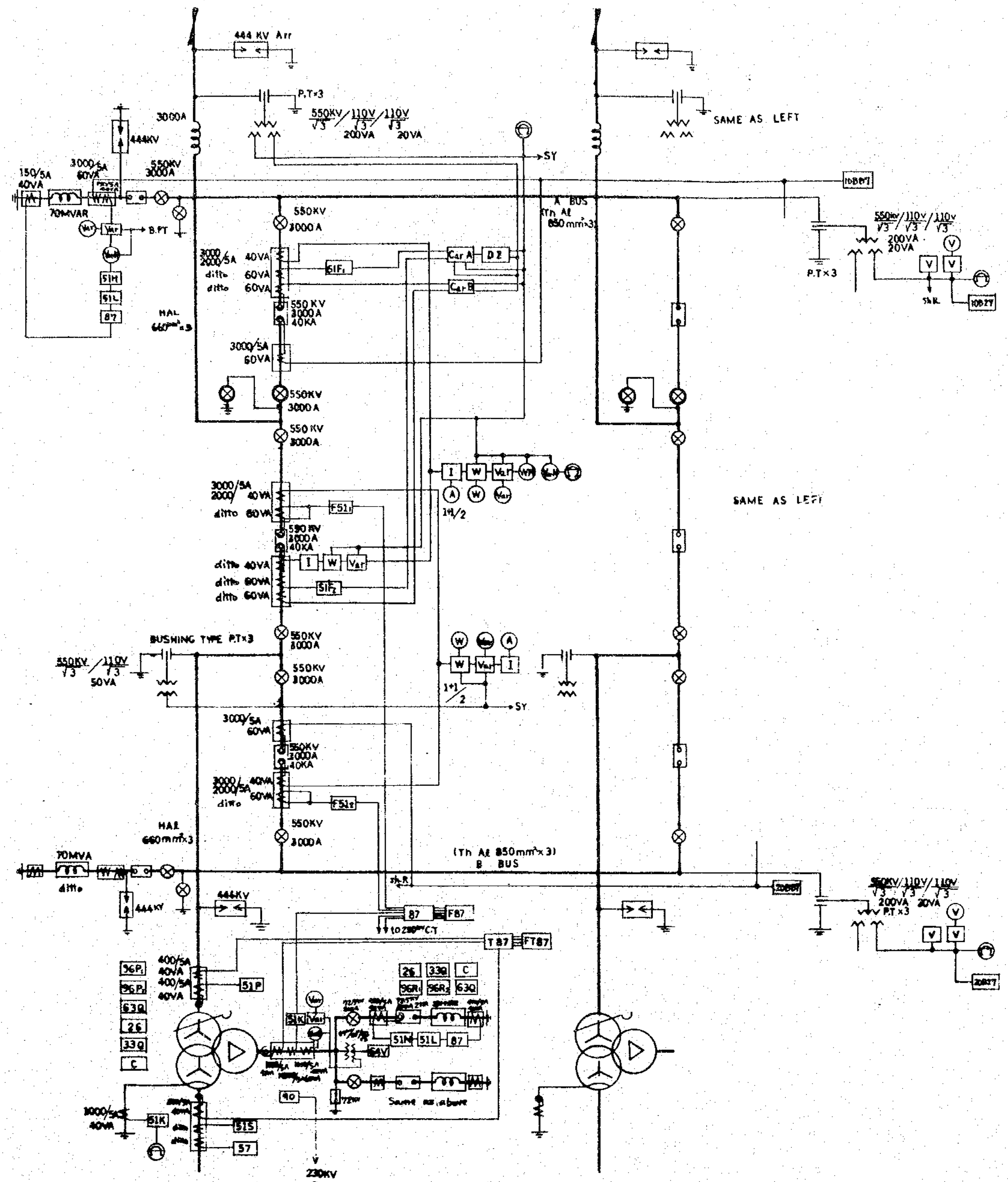
Wind velocity 0.5 m/sec
Solar radiation 0.1 W/cm^2

[referring Japanese Electric hand book]

Fig. 6-10

EHV System Tele-Communication Route

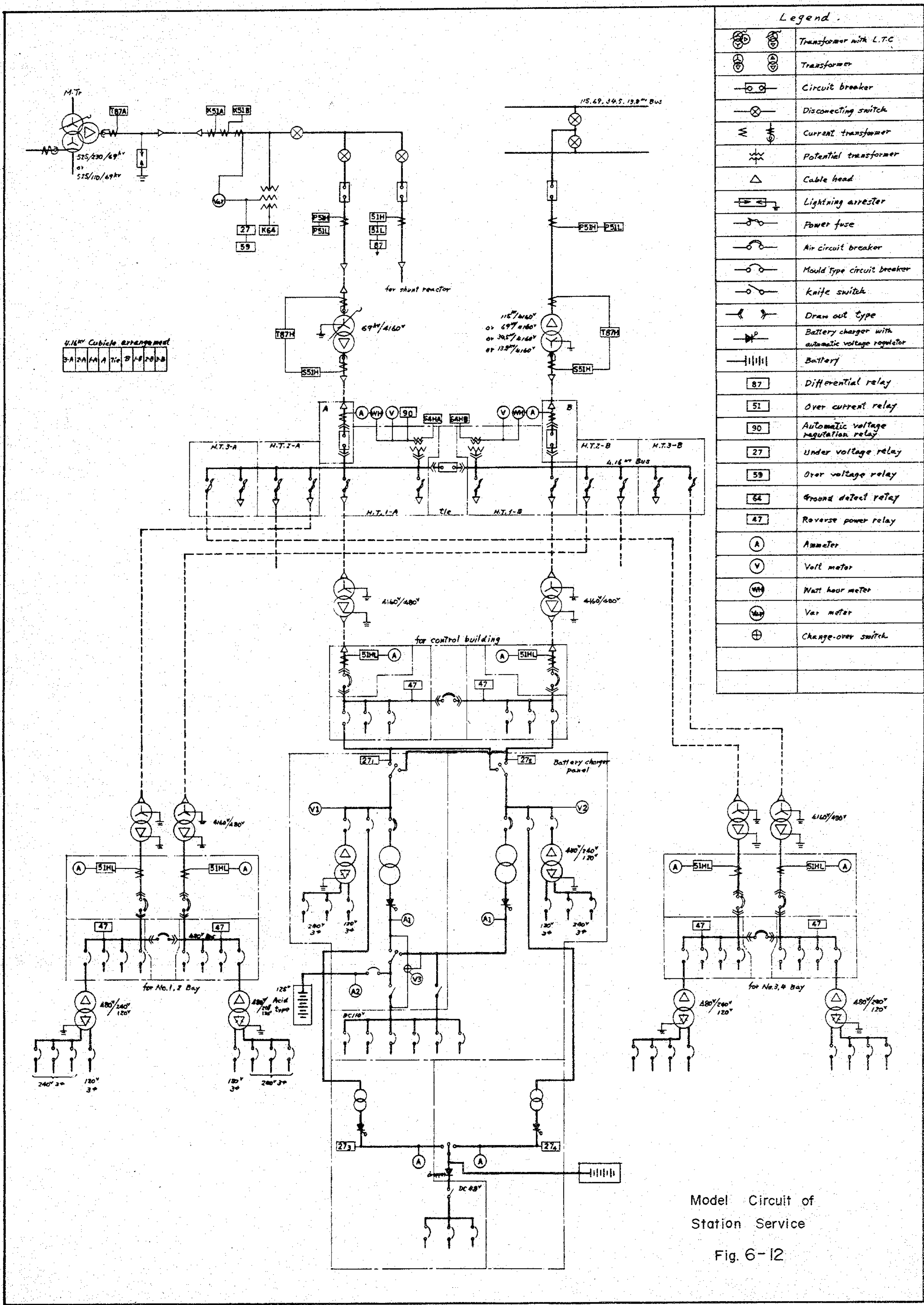




	LEGEND		
	MAIN TRANSFORMER	51	OVER CURRENT RELAY
	CIRCUIT BREAKER	CAR	CARRIER RELAY
	DISCONNECTING SWITCH MANUAL OPERATION MOTOR OPERATION	87	DIFFERENTIAL RELAY
	EARTHING SWITCH Same as above	B87	BUS PROTECTION DIFFERENTIAL RELAY
	CURRENT TRANSFORMER (BUSHING TYPE)	27	UNDER VOLTAGE RELAY
	POTENTIAL TRANSFORMER	96P₁	BUCHHOLTZ RELAY
	LIGHTING ARRESTER	96P₂	IMPULSIVE OIL PRESSURE RISE RELAY
	LINE TRAP	63Q	BURSTING TUBE ACT RELAY
	SHUNT REACTOR	26	OIL TEMPERATURE RELAY
A	AMMETER	33Q	OIL LEVEL RELAY
I	CURRENT CONVERTER	C	COOLER FAULT DETECTING RELAY
V	VOLT METER	90	VOLTAGE REGULATING RELAY
V	VOLT CONVERTER	57	COOLER CONTROL RELAY
W / W	WATT METER / WATT CONVERTER		
Var / Var	Var METER / Var CONVERTER		
	WATT HOUR METER		
	VAR HOUR METER		
	OSCILLOGRAPH ELEMENT		

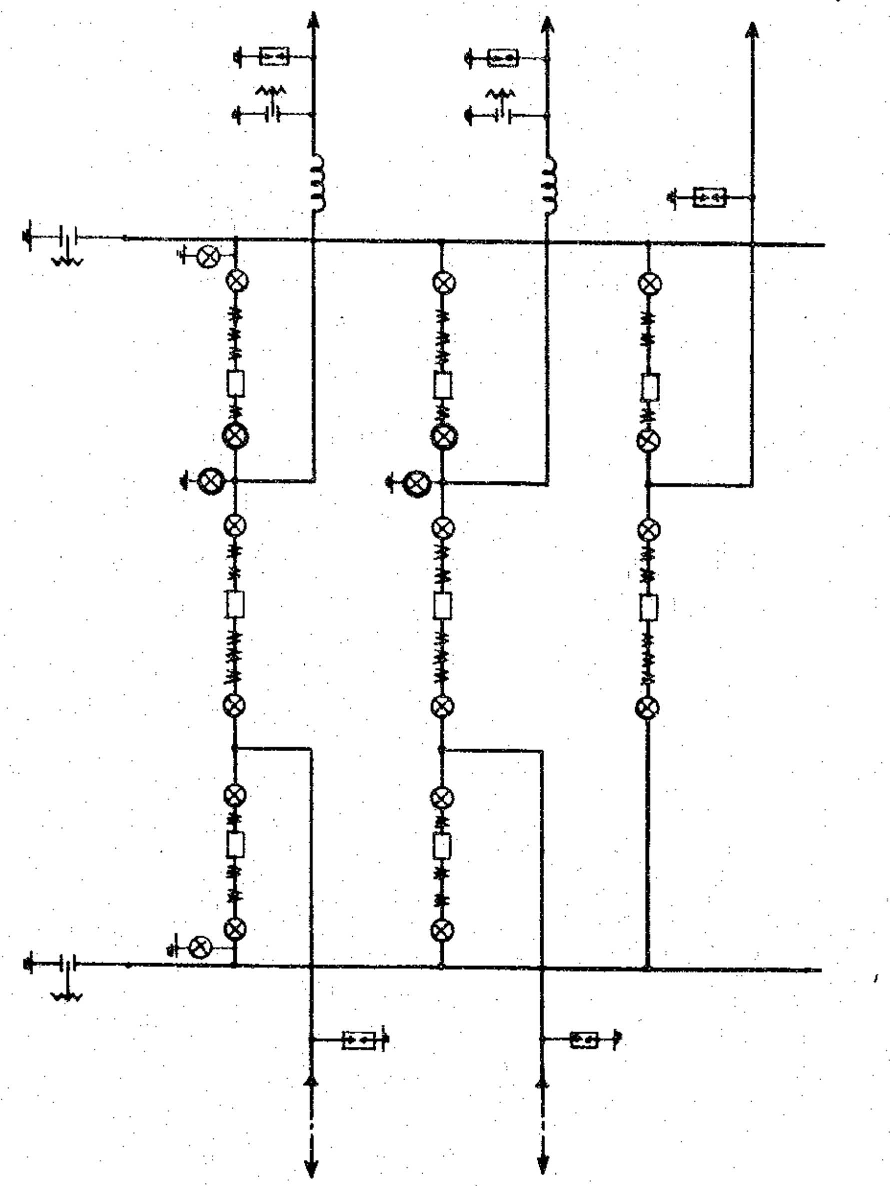
Model Circuit of EHV Substation in Luzon Grid

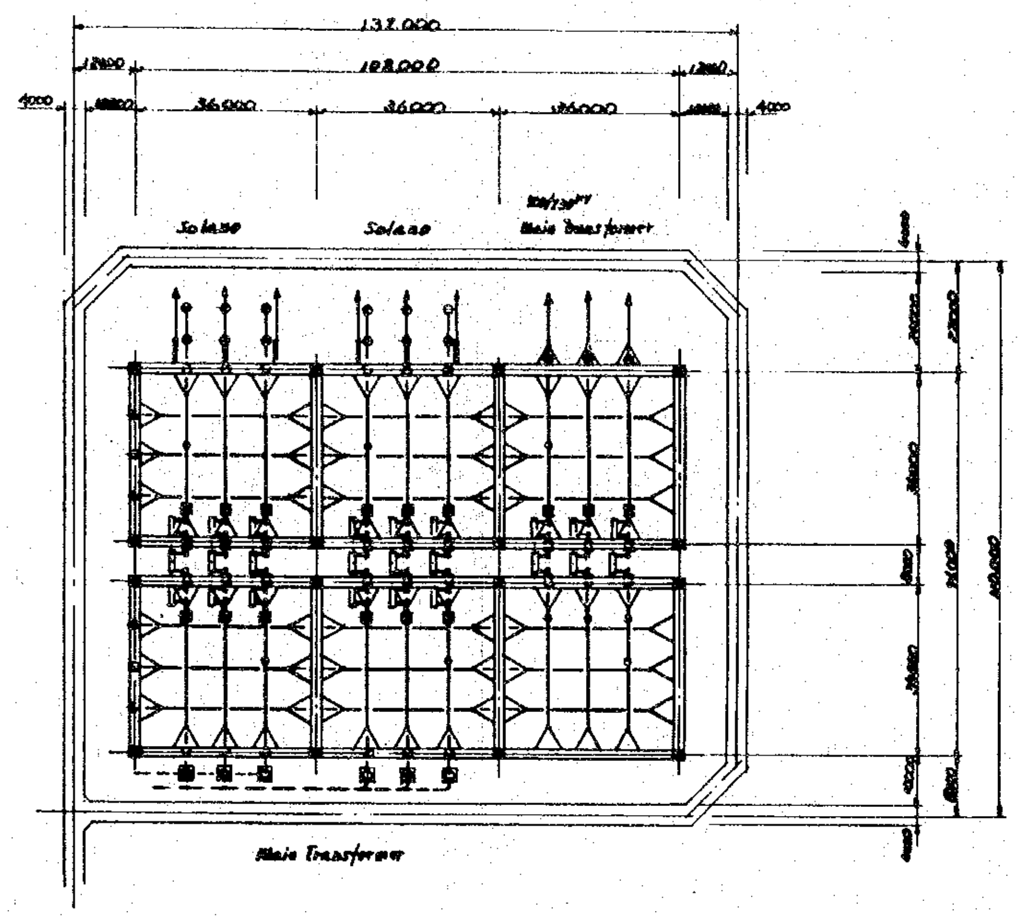
Fig.6-11



Model Circuit of Station Service

Fig. 6-12

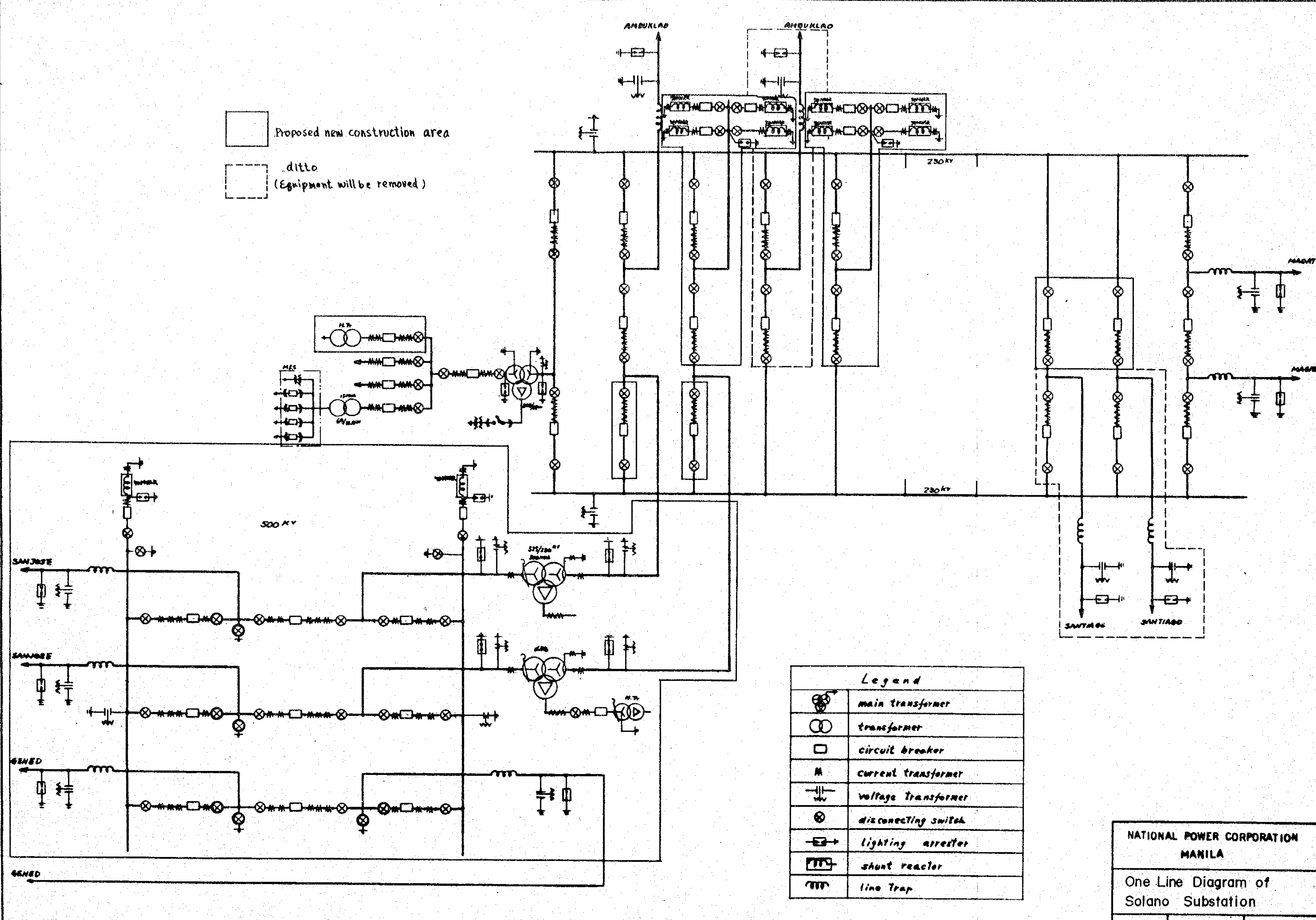




NATIONAL POWER CORPORATION
MANILA

One Line Diagram & Lay out of Gened.

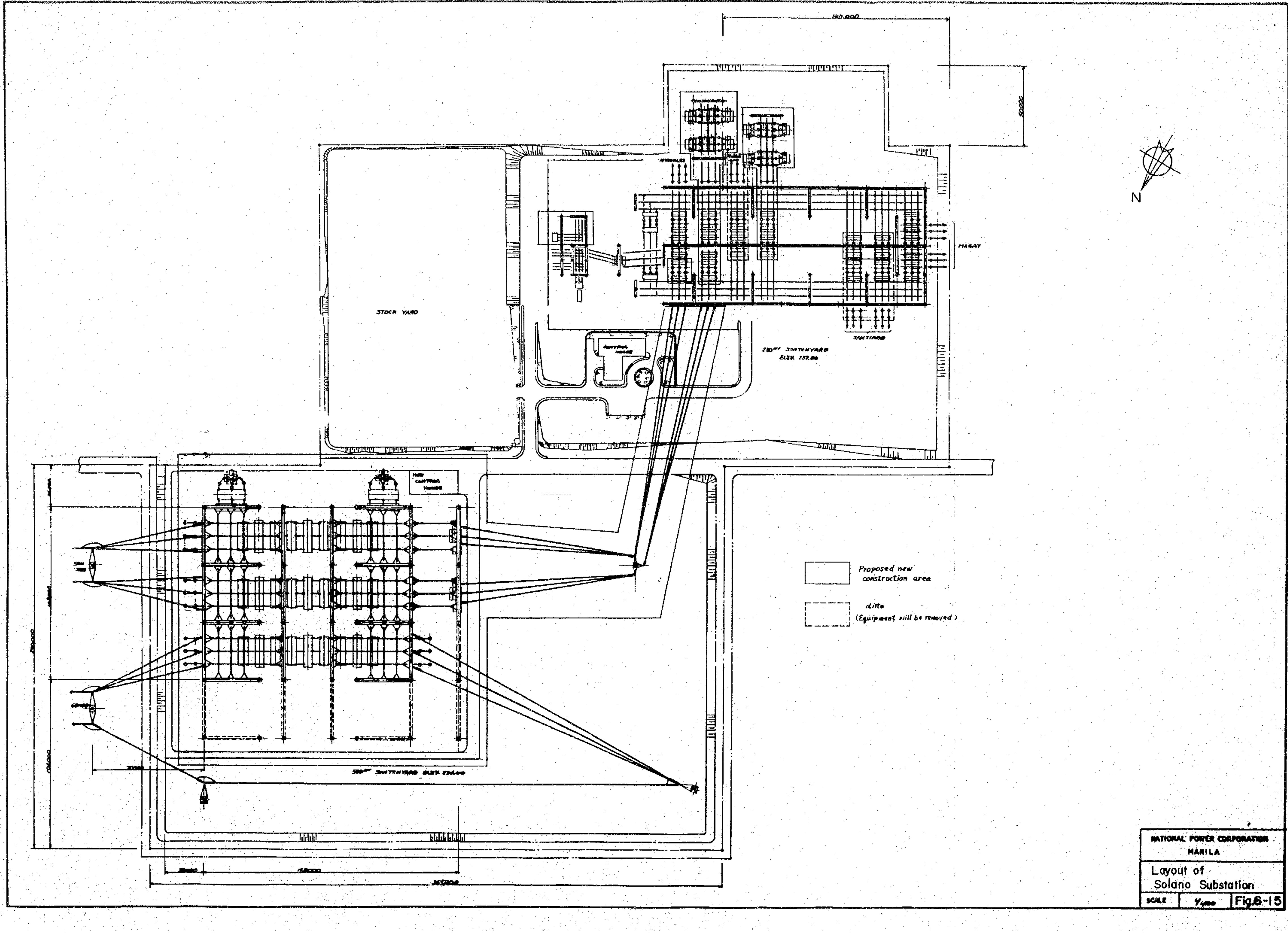
SCALE	1/1000	Fig. 6-13



NATIONAL POWER CORPORATION
MANILA

One Line Diagram of Solano Substation

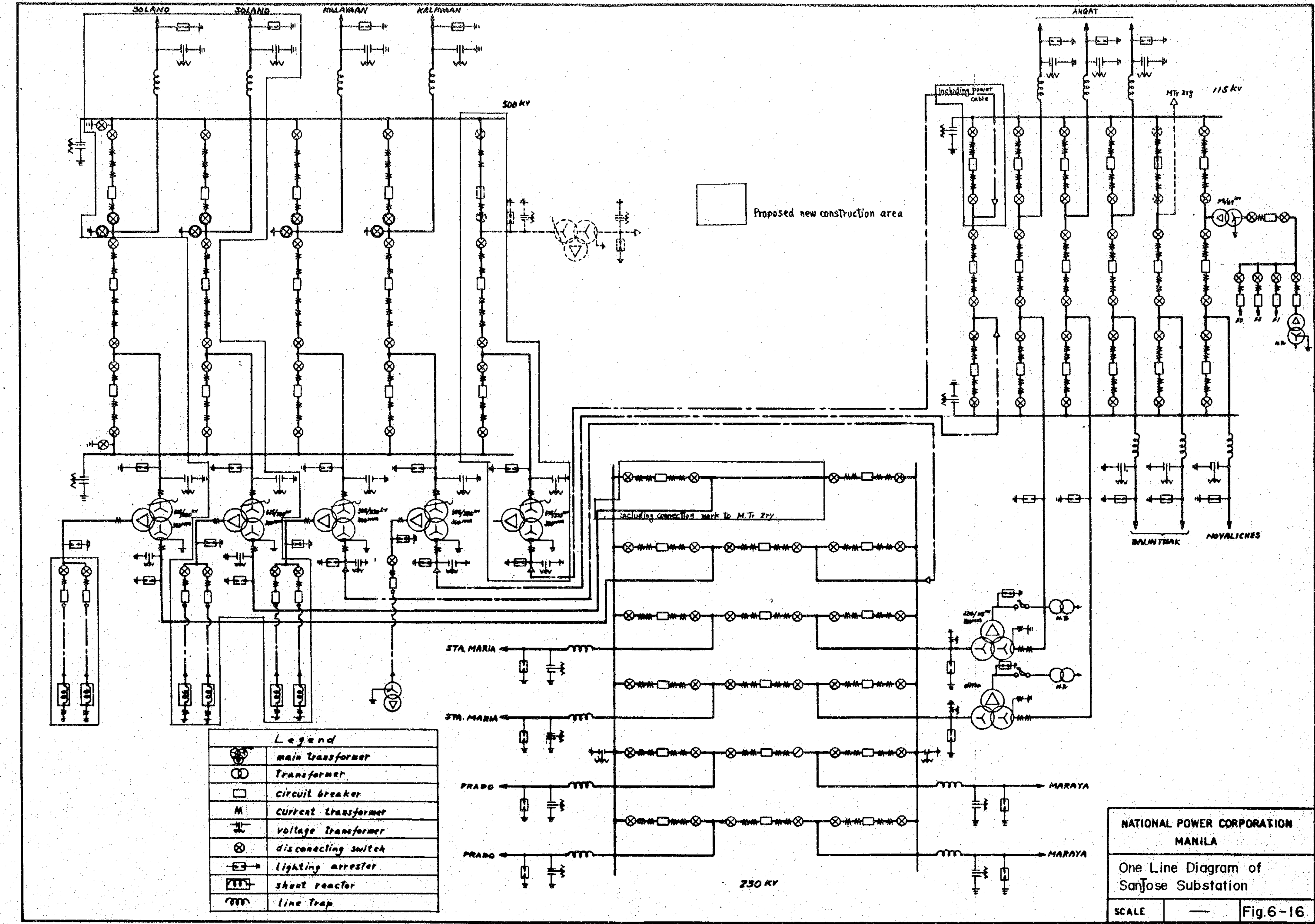
SCALE	—	Fig. 6-14



NATIONAL POWER CORPORATION
MANILA

Layout of
Solano Substation

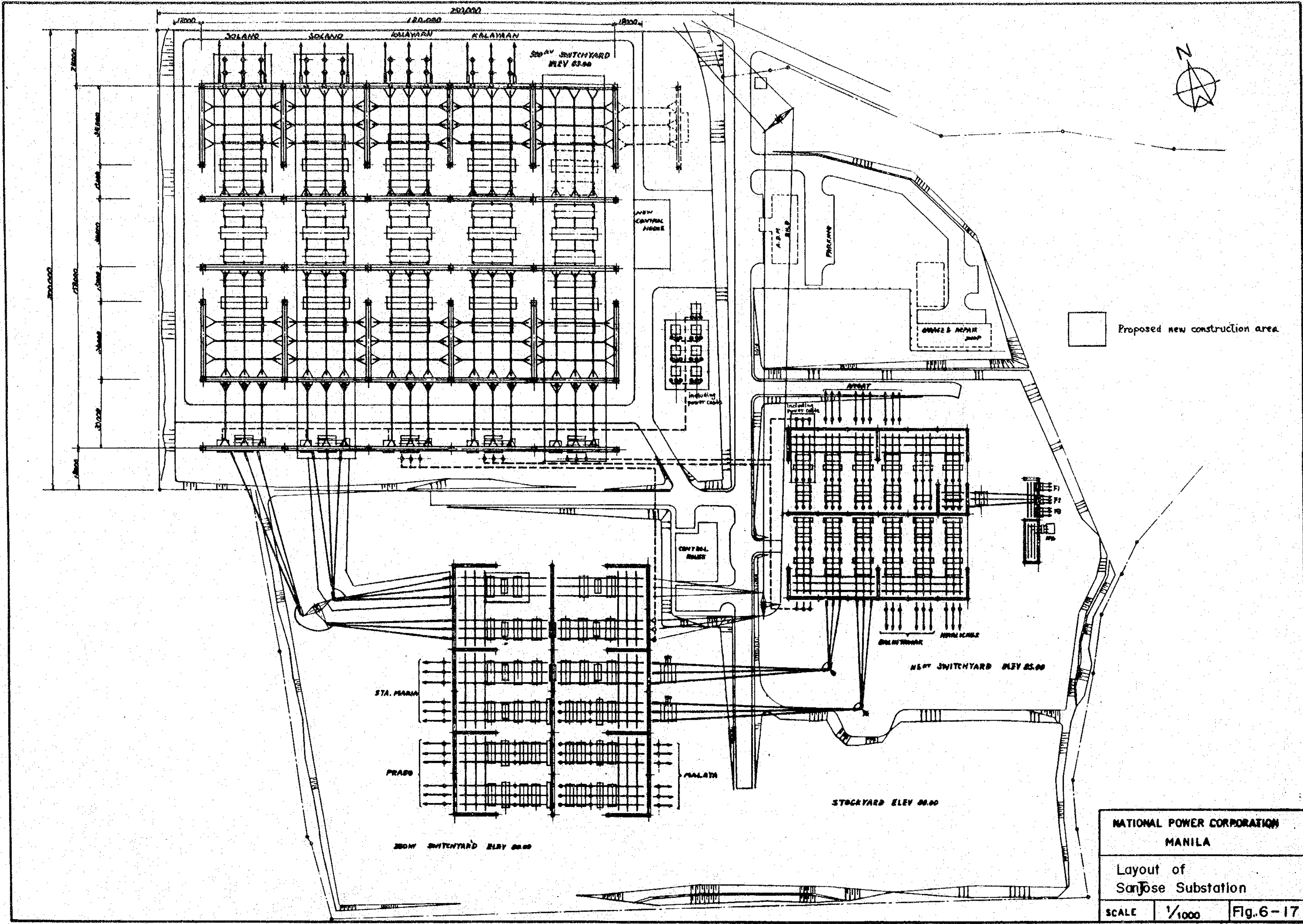
SCALE 1/4000 Fig.6-15



NATIONAL POWER CORPORATION
MANILA

One Line Diagram of San Jose Substation

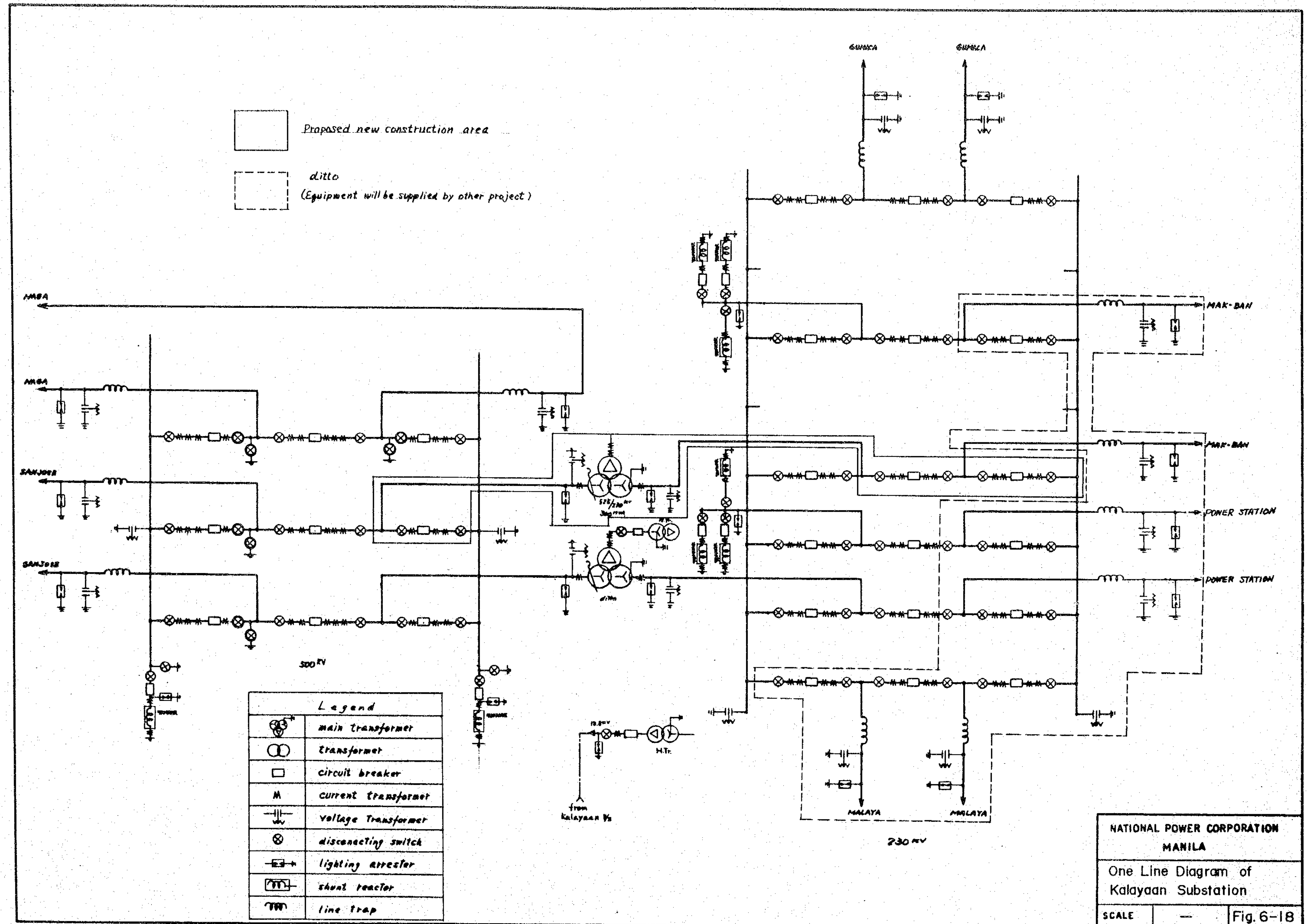
SCALE — Fig.6-16



NATIONAL POWER CORPORATION
MANILA

Layout of San Jose Substation

SCALE 1/1000 Fig. 6-17



NATIONAL POWER CORPORATION
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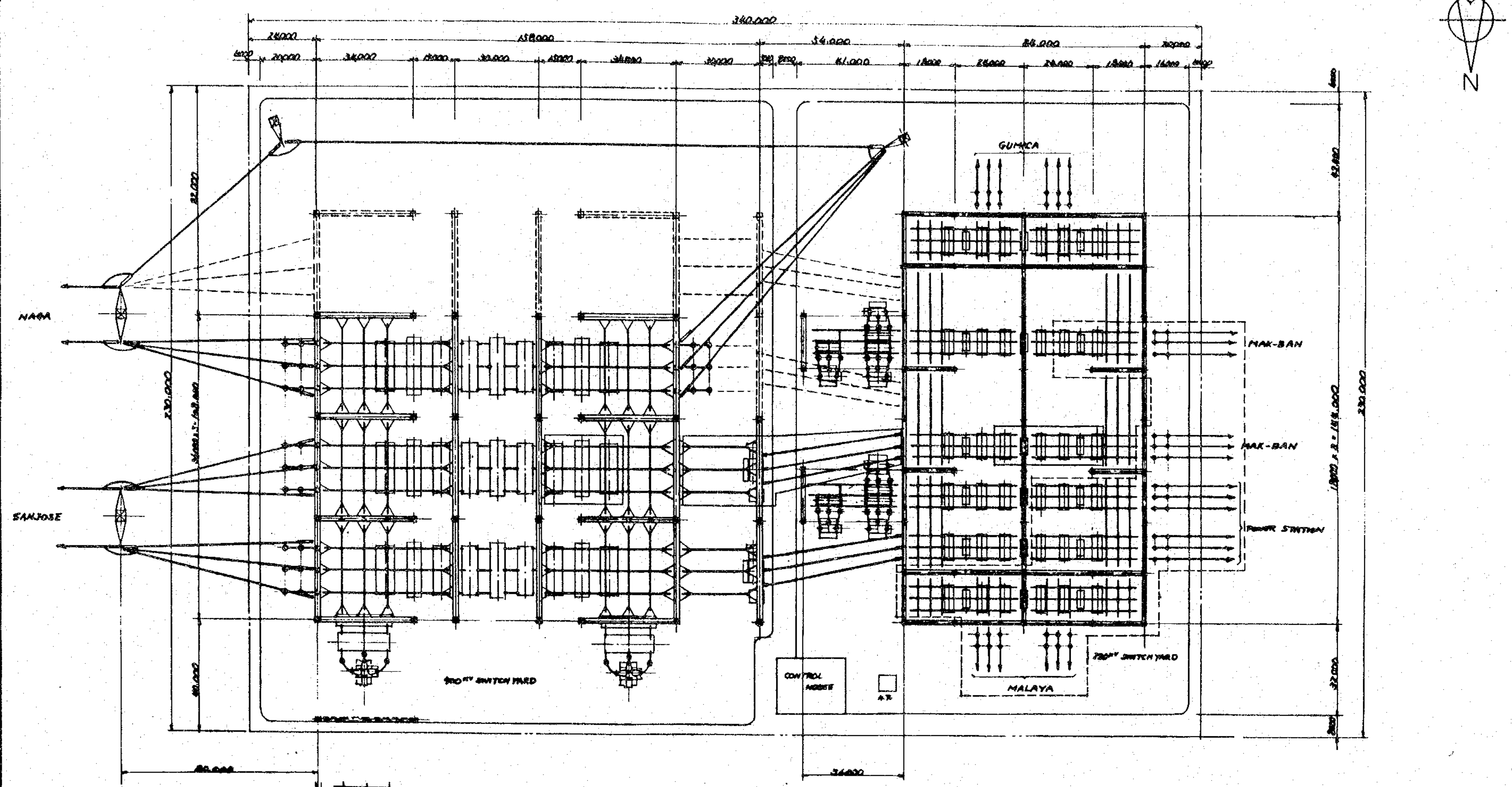
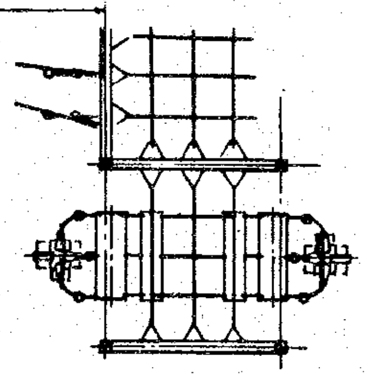
One Line Diagram of Kalayaan Substation

SCALE — Fig. 6-18





Proposed new construction area

ditto
(Equipment will be supplied by other project)

NATIONAL POWER CORPORATION MANILA	
Layout of Kalayaan Substation	
SCALE 1/1000	Fig. 6-19

7. PROJECT IMPLEMENTATION SCHEDULE AND PROGRAM

7.1. Overall Project Implementation Schedule

Shown in Fig. 2-2 is the overall project implementation schedule of the proposed transmission lines and substations included in the EHV Transmission Project.

The milestone schedule of the Project implementation is shown below:

	Transmission Line	Substation
Contract Design:	Mar.1982 - Oct.1982	Mar.1982 - Oct.1982
Tendering:	Mar.1983 - Oct.1983	Jul.1984 - Feb.1985
Manufacturing:	Jun.1984 - Dec.1986	Jul.1985 - Apr.1987
Construction:	Feb.1985 - Dec.1987	Sep.1985 - Dec.1987

The detailed manufacturing and construction schedule of the Project is presented in Fig.7-1.

7.2. Present Progress of Preparatory Work on the Sites

Reconnaissance survey of the Project has been carried out and sites of substation were already identified by NAPOCOR.

Plan and profile surveys will be prepared by NAPOCOR.

7.3. Acquisition Method of Land for Towers and Substation Sites and Right-of-Way

NAPOCOR is now carrying out the route survey on transmission line route and substation sites proposed for the Project.

The following are the standard operating procedures (SOP) of NAPOCOR for land and land right acquisitions:

(1) Land for Towers

The land right does not involve change in ownership of the land.

- verification of the ownership at the Bureau of Lands.

- Preliminary negotiation with the owner; if the owner is amenable contract is drawn up to settle the acquisition of the land.

- if negotiation fails, NAPOCOR files the appropriate claim with the Solicitor General. Then, expropriation proceedings start. The price will be fixed by the court.

(2) Sites of Substations

The land right involves the change in ownership of the property.

- NAPOCOR Right-of-Way (ROW) Agent will offer to buy the land from the owner at a price based on the assessed value of the land.

- If the owner is not amenable to the price offered, NAPOCOR and the owner will enter into negotiation.

- If negotiation fails, NAPOCOR shall file the appropriate claim with the Solicitor General. Then expropriation proceedings start. The price will be fixed by the court.

7.4. Procurement Plan of Equipment and Material

The procurement of materials, machinery and facilities except those to be supplied by NAPOCOR will be made through prequalification of bidders and bidding by those prequalified on the basis of normal international competitive bidding procedure. The exception of whether international or one specific country may be applied, depending on the requirements called for by loan sources.

On all contracts for supply of goods or for work which merit international competition, potential suppliers in all eligible countries will be canvassed for bids. Advertisements will be placed on well-known technical magazines and/or trade publications of wide international circulation as well as local newspapers whenever such are required by the source of loan. Invitation to bid and/or to prequalify bidders will be transmitted to local official representatives of those countries or sent promptly to the foreign offices of such countries which has no official representation in the Philippines.

Based on our knowledge of the standard manufacturing capacity of similar equipment and materials of experienced manufacturers and the normal construction capacity of similar EHV system of experienced contractors, the Project construction work is proposed to be divided into the following contract lots, in order to complete the construction work as scheduled.

Transmission Line	Ten (10) contractors
Substation	Three (3) contractors

The sequence and timing of the tendering procedure and construction works are shown in Figs. 2-2 and 7-1.

7.5. Procurement Plan of Technical Services

7.5.1. Engineering Services by Consultants

(1) Necessity

Engineering services are required for effective execution of the Project. The necessity is also emphasized by the fact that the Project involves EHV (500 kV) transmission line which is the first EHV project to be constructed in the country. It is an internationally recognized practice that the contract design including preparation of tender documents and construction supervision should be expected to be performed by the same consultants assigned for the feasibility study of the Project, in order to ensure consistency in the project concept, technology adopted and design concept.

(2) Appointment of Consultants

Following the internationally recognized practices, it is recommended that the appointment of consultants who will undertake the contract design and construction supervision would be made by the method of direct appointment. The timing of consulting contracts is programmed as follows:

(a) Contract design and preparation of tender documents (for all categories)

i) Conclusion of consulting contact - January 1982
ii) Commencement of services - March 1982

(b) Construction supervision

Categories	Conclusion of Consulting Contract	Commencement of Services
Transmission Line	February 1985	December 1987
Substation	September 1985	December 1987

The construction work of the Project is scheduled into 2 categories. But it will be more economical to carry out the contract designing and preparation of tender documents for the 2 categories at one time, but not into 2 consulting contracts. It is, therefore, recommended that one consulting contract for the contract design and preparation of tender documents will be executed in the above schedule.

(3) Scope of Engineering Services

(a) Preparation of contract design and preparation of tender documents

(b) Construction supervision (by categories)

i) Evaluation of tenders for procurements and constructions and recommendation of awards of contracts.

ii) Assistance in contract negotiations with awarded tenderers.

iii) Check and approval of detailed drawings and documents to be submitted by suppliers and/or contractors.

iv) Witness of factory tests and inspections of equipment and materials.

v) Supervision of contract works including:

- Coordination, engineering supervision and inspection of construction activities to enable efficient progress of all works at the site.

- Certification of percentage of completion of the erection, installation and construction works.

- Establishment of test procedures and provision of supervision and inspection of field test.

- Assistance in filling claims to suppliers and/or contractors which may arise during the delivery and construction phases in accordance with the provisions for the contracts with them.

vi) Assistance in acceptance tests of the project component structures and equipment.

vii) Compilation of construction record.

(c) Training of NAPOCOR personnel in design, construction supervision and maintenance/operation.

7.5.2. Field Technical Guidance by Contractors

(1) Necessity

The main difficulties in the execution of the construction work of the 500 kV transmission system lie on the following field operations:

(a) Setting of tower foundations without use of templates.

(b) Adjustment of tower foundation levels in the mountainous part of the transmission line route.

(c) Erection of high tower structures with steel members of long arm length.

(d) Pulling and tensioning of 4 bundle conductors with a special equipment in the mountainous part of the line route.

(e) Clamping of conductors to suspension clamps.

(f) Installation of large-scaled transformers, circuit breakers, and control panel and protection relays including cable/wiring connections.

(g) Erection of steel structures

For the smooth and effective execution of the construction works, it will also be necessary to procure field technical foremen and technicians experienced in the construction works of the 500 kV transmission lines, particularly the above operations, in the respective contract lots of supply and construction.

(2) Procurement and Technical Guidance

The guidance services by technical foremen and technicians will be procured within each contract lot for which International bidding will be invited.

7.6. Transportation Method of Construction Equipment and Materials to the Site

(1) Most of the construction equipment, materials and tools

necessary for the Project are planned to be imported from foreign countries. For unloading the above-mentioned equipment and materials, Manila Port and Casambalangan Port are recommended due to their well-equipped facilities for loading and unloading as well as their proximity to the Project Sites.

2) The construction equipment and materials of transmission line unloaded at the above ports will be transported through the Pan-Philippine Highway to the warehouses and the stockades arranged by the contractors. The construction equipment and materials for the substations will be transported to the warehouses and stockades at the substation sites provided by NAPOCOR.

In consideration of road conditions, the transportation of equipment and materials shall be limited to unit weight of forty (40) tons and a height of four (4) meters. Rehabilitation of bridges, special carrying means such as trailers, and traffic control will be requested for the transportation of EHV transformers.

3) The materials of transmission lines assorted at the Contractor's warehouses or stockades as mentioned above shall be delivered to each contractor's stockyards on the site by means of car and national railway transportation.

4) The materials of transmission lines and other construction materials such as cement, aggregates, etc. which are supplied locally shall be transported from the stockyard belonging to contractors to the tower sites proposed in the EHV transmission line by way of contractor's manpower and available means of transportation.

7.7. Method of Prosecution of Construction Works

(1) The construction facilities for the EHV transmission line project are in large scale and the construction works are much more complicated in comparison with those of 230 kV transmission line projects, and the prosecution of construction works for the EHV transmission line project shall be pursued in a manner ensuring optimum reliability and soundness.

Therefore, only contractors with extensive experiences in similar projects in foreign countries shall be considered during the prequalification stage prior to tendering.

(2) For successful completion of this project, the complicated construction works of transmission lines and substations for EHV transmission line project shall be prosecuted effectively by the contractors in equal level of experiences under a full turnkey contract base. Accordingly, each contractor shall be responsible for construction works and acceptance tests as well as their own supply of construction equipment and materials, tools, etc. necessary for successful completion of the Project.

(3) Drawing approval and factory tests of imported equipment and materials and construction supervision of prosecution of construction works by the contractors shall be done with the management of consultants in association with NAPOCOR.

(4) Construction Work of Transmission Lines

Erection work of about 1,000 towers shall be carried out within twenty-eight (28) months by the proposed ten (10) contractors (five (5) sub-contractors for each contractor). Stringing work of about 400 km shall start seven (7) months after commencement of tower erection work and shall also be completed within twenty-eight (28) months by proposed ten (10) contractors. The completion time is scheduled in December, 1987.

During the construction of the project, overlapping of works undertaken by these contractors can not be avoided. In order to ensure the successful prosecution of the construction works, the contractors are requested to arrange for ten (10) sets each of special derricks (slide-up type) for erection of EHV towers and one (1) set each of tensioners, engine pullers, reel winders, stringing sheaves and other tools for stringing work of the EHV 4-bundle transmission lines.

5) Construction Work of Substations

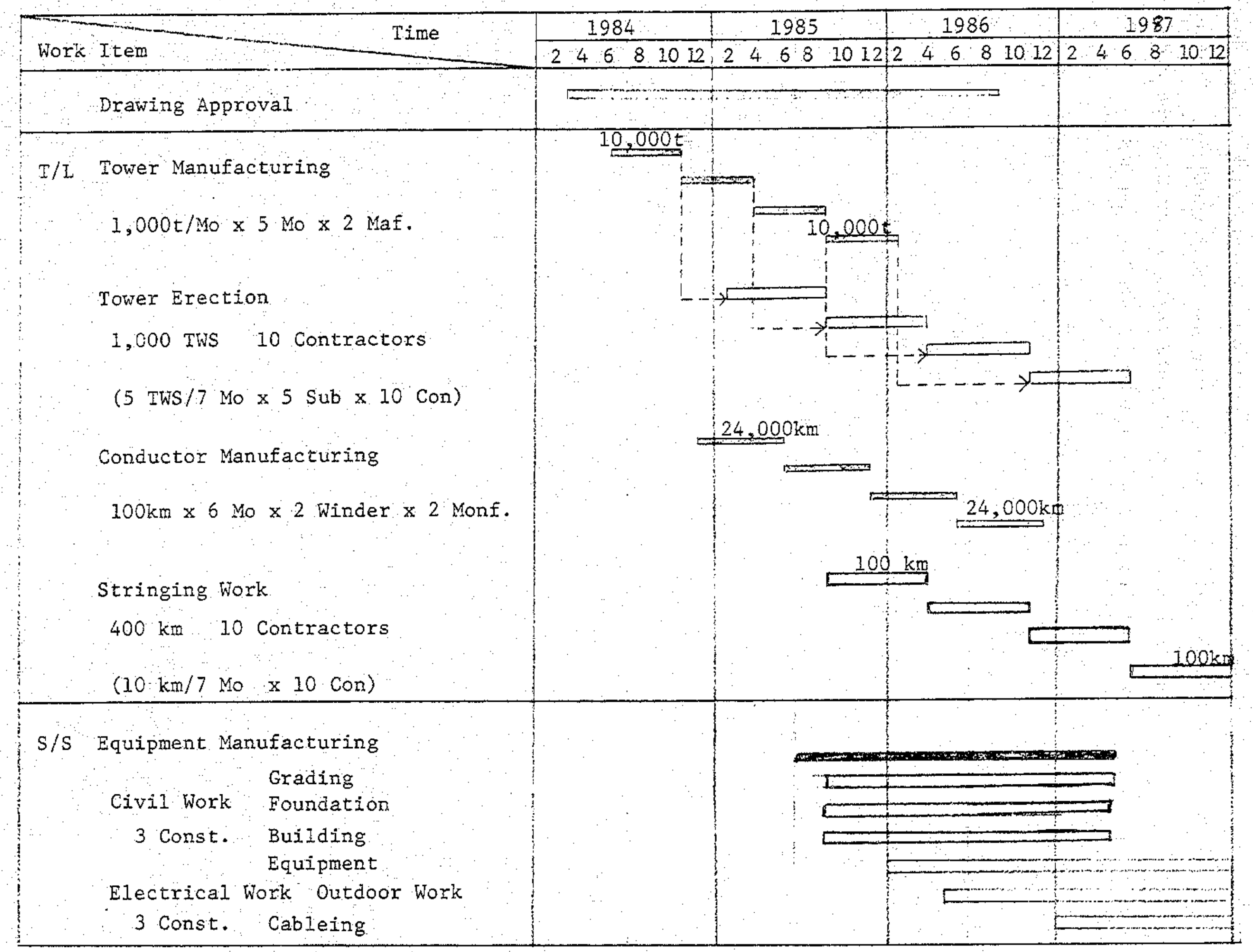
Construction of Solano Substation and expansion works of San Jose and Kalayaan Substations are scheduled to start on September 1985 and January 1986 respectively. One contractor for Solano Substation shall execute the civil works such as grading, foundation for equipment and control building within twenty (20) months, and the electrical works such as grounding mesh work, installation of equipment and wiring of control cables at three substations shall start by three contractors, midway during the construction of civil works to ensure completion of the work within twenty-four (24) months by December 1987.

6) Training Plan of Local Construction Force

Construction works of both transmission lines and substations will be executed simultaneously by the contractors under a full turnkey contract. Cooperation between contractors and NAPOCOR and/or its consultants will be needed for the early completion of the project.

During the construction period, local construction force being utilized will undergo on-the-job-training. This is in line with the scheme of transfer of technology. Trained local personnel will constitute the key force in the undertaking of future EHV projects in the Philippines.

Fig. 7-1 Manufacturing and Construction Schedule



8. ESTIMATED CONSTRUCTION COSTS OF THE PROJECT

8.1. Capital Cost Estimates

The capital costs of the Project are estimated at Philippine Pesos 5,716,820,000 whose breakdown into foreign and local currency components and by categories are shown below:

Category	Foreign Currency (US$)	Local Currency (Pesos)	Total (Peso Equivalent)
Transmission Line	277,174,000	2,861,016,000	4,564,821,000
Substation	85,543,000	510,426,000	1,151,999,000
TOTAL	312,717,000	3,371,442,000	5,716,820,000

The particulars of the cost estimates are shown in Tables 8-1 to 8-4(4)

8.2. Basis of Estimates

The estimates are based on present-day costs of foreign and local labour, materials and equipment with escalation added necessary to cover the rise in cost during the construction.

The estimated construction cost does not include the cost related to the countermeasures for radio and television interferences and for electromagnetic induction disturbance to the communication lines, which might be caused by the construction of the Project.

In the cost estimate, an exchange rate of US$1 to Pesos 7.50 was used.

Items noted in the estimates are defined as follows:

8.2.1. Transmission Line Work

Manufacture, delivery, erection and commissioning of materials necessary for the transmission line work of the Project, whose cost was estimated in accordance with the diagram shown in Fig.8-1 (Procedure of Cost Estimates for Transmission Line Work).

8.2.2. Substation Work

Manufacture, delivery, erection and commissioning of materials and equipment for the installation of substations included in the Project, whose cost was estimated in accordance with the diagram shown in Fig.8-2 (Procedure of Cost Estimates for Substation Work).

8.2.3. Engineering Cost

An amount equivalent to 7.5% of the total estimated cost of the Transmission Line Work and Substation Work to cover the engineering cost for the construction supervision.

8.2.4. NAPOCOR Administration

An allowance of 2.5% of the total estimated cost of the Transmission Line Work and Substation Work to cover the NAPOCOR administration cost of construction.

8.2.5. Contingencies

An allowance for both foreign and local costs computed at the respective rates of 5% and 15% of the sum of the estimated costs for the Transmission Line Work, Substation Work, engineering cost and NAPOCOR administration.

8.2.6. Price Escalation

An allowance to cover price increases on the estimated foreign and local costs of the Transmission Line Work, Substation Work, engineering cost, NAPOCOR administration and contingencies with the following percentages:

	Foreign Cost	Local Cost
1981	10.5%	20%
1982	9%	20%
1983	8%	20%
1984	7%	20%
1985	7%	20%
After 1986	7%	20%

8.2.7. Interest During Construction

Interest during construction for both foreign and local costs computed at the rate of 8.5% capitalized up to the time when the Project is commissioned.

8.3. Foreign and Local Currency Components

8.3.1. Foreign Currency

Main cost items included in foreign currency portion covers:

(a) Procurement cost of conductors, overhead ground wires, line hardware, insulators and accessories and tower steel material for transmission lines, and substation structural steels, substation transformers, reactors, switching equipment, protective relays and apparatus and communication equipment for substations.

(b) Purchase cost of construction equipment, tools and instruments.

(c) Costs of consulting engineering services for construction supervision and technical guidances for field erection and installation.

8.3.2. Local Currency

The local expenditure includes local labour and cost of materials produced or manufactured in the Philippines. They include cement, reinforcing bars, aggregates, timbers, fuel, gasoline, explosives and mobile oil as well as local transportation. In addition, the transmission right-of-way, tower and substation sites acquisition costs and administration and engineering fee of NAPOCOR are included in the local currency components.

8.4. Disbursement Schedule

The estimated schedule of yearly expenditures in shown in Table 8-5 to 8-7.

Table 8-1 Summary of Construction Cost Estimates

	Item	Amount (Unit: In Thousand) Foreign Cost (US$)	Local Cost (Pesos)	Total (Pesos)
1.	Transmission Line	126,109	714,481	1,660,299
2.	Substation	46,783	111,023	461,895
3.	Total direct cost (1 + 2)	172,892	825,504	2,122,194
4.	Engineering cost	13,795	55,707	159,170
5.	NAPOCOR administration	-	53,055	53,055
6.	Sub-total	186,687	934,266	2,334,419
7.	Contingencies	9,334	140,140	210,145
8.	Sub-total (6 + 7)	196,021	1,074,406	2,544,564
9.	Price escalation	116,696	2,297,036	3,172,256
10.	Total capital cost (8 + 9)	312,717	3,371,442	5,716,820
11.	Interest during construction	17,448	-	130,860
12.	Grand Total (10 + 11)	330,165	3,371,442	5,847,680

Table 8-2 <u>Detailed Breakdown of Construction Cost by Categories</u>

(Unit: In Thousand)

Item	Transmission Line			Substation			Total		
	F.C.(US$)	L.C.(₱)	Total(₱)	F.C.(US$)	L.C.(₱)	Total(₱)	F.C.(US$)	L.C.(₱)	Total(₱)
1. Transmission line	126,109	714,481	1,660,298.5	-	-	-	126,109	714,481	1,660,299
2. Substation	-	-	-	46,783	111,023	461,896	46,783	111,023	461,895
3. Total direct cost (1 + 2)	126,109	714,481	1,660,298.5	46,783	111,023	461,896	172,892	825,504	2,122,194
4. Engineering cost	10,792	43,583	124,523	3,003	12,124	34,646	13,795	55,707	159,170
5. NAPOCOR administration	-	41,507	41,507	-	11,548	11,548	-	53,055	53,055
6. Sub-total (3 + 4 + 5)	136,901	799,571	1,826,328.5	49,786	134,695	508,090	186,687	934,266	2,334,419
7. Contingencies	6,845	119,936	171,273.5	2,489	20,204	38,872	9,334	140,140	210,145
8. Sub-total (6 + 7)	143,746	919,507	1,997,602	52,275	154,899	546,962	196,021	1,074,406	2,544,564
9. Price escalation	83,428	1,941,509	2,567,219	33,268	355,527	605,037	116,696	2,297,036	3,172,256
10. Total Capital Cost (8 + 9)	227,174	2,861,016	4,564,821	85,543	510,426	1,151,999	312,717	3,371,442	5,716,820
11. Interest during construction	13,610	-	102,075	3,838	-	28,785	17,448	-	130,860
Grand Total (10 + 11)	240,784	2,861,016	4,666,896	89,381	510,426	1,180,784	330,165	3,371,442	5,847,680

Table 8-3 Details of Construction Cost for Gened-San Jose Transmission Line

(Unit: In Thousand)

Item	Foreign Cost (US $)	Local Cost (Pesos)	Total (Pesos)
1. Steel towers	47,304	0	354,780
2. Insulators, hardwares accessories and tower dressing	23,705	0	177,788
3. Conductors, ground wires and accessories	49,364	0	370,230
4. Tools and equipment rental	5,736	0	43,020
5. Sub-total (1 - 4)	126,109	0	945,818
6. Erection of towers including foundations	0	606,096	606,096
7. Stringing of conductors and ground wires	0	91,664	91,664
8. Sub-total (6 + 7)	0	697,760	697,760
9. Right-of-Way	0	16,721	16,721
10. Sub-total (5 + 8 + 9)	126,109	714,481	1,660,299
11. Engineering cost	10,792	43,583	124,523
12. NAPOCOR administration	0	41,507	41,507
13. Sub-total (10 + 11 + 12)	136,901	799,571	1,826,329
14. Contingencies	6,845	119,936	171,273
15. Sub-total (13 + 14)	143,746	919,507	1,997,602
16. Price escalation	83,428	1,941,509	2,567,219
Total	227,174	2,861,016	4,564,821

Table 8-4 Details of Construction Cost for Substations

(Unit: In Thousand)

Item	Foreign Cost (US $)	Local Cost (Pesos)	Total (Pesos)
1. Transformer and switching equipment	46,647	-	349,852
2. Communication	136	-	1,020
3. Civil works	-	55,448	55,448
4. Erection and installation work	-	55,035	55,035
5. Sub-total (1 + 2 + 3 + 4)	46,783	110,483	461,356
6. Land acquisition	-	540	540
7. Sub-total (5 + 6)	46,783	111,023	461,896
8. Engineering cost	3,003	12,124	34,646
9. NAPOCOR administration	-	11,548	11,548
10. Sub-total (7 + 8 + 9)	49,786	134,695	508,090
11. Contingencies	2,489	20,204	38,872
12. Sub-total (10 + 11)	52,275	154,899	546,962
13. Price escalation	33,268	355,527	605,037
Total Capital Cost (12 + 13)	85,543	510,426	1,151,999

Table 8-4(1) Details of Construction Cost for Solano Substation

(Unit: In Thousand)

Item	Foreign Cost (US$)	Local Cost (Pesos)	Total (Pesos)
1. Transformer and switching equipment	22,208	-	166,560
2. Communication	72	-	540
3. Civil works	-	26,977	26,977
4. Erection and installation work	-	22,612	22,612
5. Sub-total (1 + 2 + 3 + 4)	22,208	49,589	216,689
6. Land acquisition	-	540	540
7. Sub-total (5 + 6)	22,280	50,129	217,229
8. Engineering cost	1,413	5,701	16,299
9. NAPOCOR administration	-	5,429	5,429
10. Sub-total (7 + 8 + 9)	23,693	61,259	238,957
11. Contingencies	1,184	9,187	18,067
12. Sub-total (10 + 11)	24,877	70,446	257,024
13. Price escalation	15,832	161,691	280,431
Total Capital Cost (12 + 13)	40,709	232,137	537,455

Table 8-4 (2) Details of Construction Cost for San Jose Substation

(Unit: In Thousand)

Item	Foreign Cost (US$)	Local Cost (Pesos)	Total (Pesos)
1. Transformer and switching equipment	11,759	-	88,192
2. Communication	32	-	240
3. Civil works	-	6,945	6,945
4. Erection and installation work	-	11,220	11,220
5. Sub-total (1 + 2 + 3 + 4)	11,791	18,165	106,598
6. Land acquisition	-	-	-
7. Sub-total (5 + 6)	11,791	18,165	106,598
8. Engineering cost	693	2,798	7,995
9. NAPOCOR administration	-	2,670	2,670
10. Sub-total (7 + 8 + 9)	12,484	23,633	117,263
11. Contingencies	624	3,548	8,228
12. Sub-total (10 + 11)	13,108	27,181	125,491
13. Price escalation	8,342	62,384	124,949
Total Capital Cost (12 + 13)	21,450	89,565	250,449

Table 8-4 (3) Details of Construction Cost for Kalayaan Substation

(Unit: In Thousand)

Item	Foreign Cost (US $)	Local Cost (Pesos)	Total (Pesos)
1. Transformer and switching equipment	4,683	-	35,123
2. Communication	32	-	240
3. Civil works	-	6,428	6,428
4. Erection and installation work	-	9,953	9,953
5. Sub-total (1 + 2 + 3 + 4)	4,715	16,381	51,744
6. Land acquisition	-	-	-
7. Sub-total (5 + 6)	4,715	16,381	51,744
8. Engineering cost	336	1,359	3,879
9. NAPOCOR administration	-	1,290	1,290
10. Sub-total (7 + 8 + 9)	5,051	19,030	56,913
11. Contingencies	253	2,857	4,755
12. Sub-total (10 + 11)	5,304	21,887	61,668
13. Price escalation	3,375	50,236	75,548
Total Capital Cost (12 + 13)	8,679	72,123	137,216

Table 8-4 (4) Details of Construction Cost for Gened Substation

(Unit: In Thousand)

Item	Foreign Cost (US$)	Local Cost (Pesos)	Total (Pesos)
1. Transformer and switching equipment	7,997	-	59,977
2. Communication	-	-	-
3. Civil works	-	15,098	15,098
4. Erection and installation work	-	11,250	11,250
5. Sub-total (1 + 2 + 3 + 4)	7,997	26,348	86,325
6. Land acquisition	-	-	-
7. Sub-total (5 + 6)	7,997	26,348	86,325
8. Engineering cost	561	2,266	6,473
9. NAPOCOR administration	-	2,159	2,159
10. Sub-total (7 + 8 + 9)	8,558	30,773	94,957
11. Contingencies	428	4,612	7,822
12. Sub-total (10 + 11)	8,986	35,385	102,779
13. Price escalation	5,719	81,216	124,109
Total Capital Cost (12 + 13)	14,705	116,601	226,888

Table 8-5 Disbursement Schedule of Project Cost (Transmission)

(Unit : In Thousand)

Category		Cost Item / Year	1984	1985	1986	1987	1988	1989	Total
Gened - San Jose Transmission Line	Foreign Currency Cost ($)	Direct Cost	5,044	40,355	45,399	22,700	-	12,611	126,109
		Engineering	2,698	2,698	2,698	2,698	-	-	10,792
		Administration	-	-	-	-	-	-	-
		Sub-total	7,742	43,053	48,097	25,398	-	12,611	136,901
		Contingencies	387	2,153	2,404	1,270	-	631	6,845
		Sub-total	8,129	45,206	50,501	26,668	-	13,242	143,746
		Price Escalation	3,187	22,106	29,998	18,801	-	9,336	83,428
		Sub-total	11,316	67,312	80,499	45,469	-	22,578	227,174
		Interest during Construction	339	2,359	4,774	6,138	-	-	13,610
		Total	11,655	69,671	85,273	51,607	-	22,578	240,784
	Local Currency Cost (₱)	Direct Cost	-	142,897	285,792	285,792	-	-	714,481
		Engineering	1,053	12,402	17,433	12,695	-	-	43,583
		Administration	1,002	11,811	16,603	12,091	-	-	41,507
		Sub-total	2,055	167,110	319,828	310,578	-	-	799,571
		Contingencies	308	25,067	47,974	46,587	-	-	119,936
		Sub-total	2,363	192,177	367,802	357,165	-	-	919,507
		Price Escalation	2,538	285,959	730,455	922,557	-	-	1,941,509
		Total	4,901	478,136	1,098,257	1,279,722	-	-	2,861,016
		GRAND TOTAL (₱)	92,313	1,000,668	1,737,805	1,666,775	-	169,735	4,668,896

Table 8-6 Disbursement Schedule of Project Cost (Substation)

(Unit : In Thousand)

Category		Cost Item / Year	1984	1985	1986	1987	1988	1989	Total
Solano, San Jose, Kalayaan and Gened Substations	Foreign Currency Cost ($)	Direct Cost		4,678	18,713	18,713	-	4,679	46,783
		Engineering		1,001	1,001	1,001	-	-	3,003
		Administration		-	-	-	-	-	-
		Sub-total		5,679	19,714	19,714	-	4,679	49,786
		Contingencies		284	986	986	-	233	2,489
		Sub-total		5,963	20,700	20,700	-	4,912	52,275
		Price Escalation		2,916	12,295	14,593	-	3,464	33,268
		Sub-total		8,879	32,995	35,293	-	8,376	85,543
		Interest during Construction		267	1,256	2,315	-	-	3,838
		Total		9,146	34,251	37,608	-	8,376	89,381
	Local Currency Cost (₱)	Direct Cost		11,702	22,205	77,716	-	-	111,023
		Engineering		4,041	4,041	4,042	-	-	12,124
		Administration		3,849	3,849	3,850	-	-	11,548
		Sub-total		18,992	30,095	85,608	-	-	134,695
		Contingencies		2,849	4,514	12,841	-	-	20,204
		Sub-total		21,841	34,609	98,449	-	-	154,899
		Price Escalation		32,499	68,734	254,294	-	-	355,527
		Total		54,340	103,343	352,743	-	-	510,426
		GRAND TOTAL (₱)		122,935	360,226	634,803	-	62,820	1,180,784

Table 8-7 Disbursement Schedule of Project Cost (Total)

(Unit : In Thousand)

Category		Cost Item / Year	1984	1985	1986	1987	1988	1989	Total
Total Project (Categories Transmission Line and Substation)	Foreign Currency Cost ($)	Direct Cost	5,044	45,033	64,112	41,413	-	17,290	172,892
		Engineering	2,698	3,699	3,699	3,699	-	-	13,795
		Administration	-	-	-	-	-	-	-
		Sub-total	7,742	48,732	67,811	45,112	-	17,290	186,687
		Contingencies	387	2,437	3,390	2,256	-	864	9,334
		Sub-total	8,129	51,169	71,201	47,368	--	18,154	196,021
		Price Escalation	3,187	25,022	42,293	33,394	-	12,800	116,696
		Sub-total	11,316	76,191	113,494	80,762	-	30,954	312,717
		Interest during Construction	339	2,626	6,030	8,453	-	-	17,448
		Total	11,655	78,817	119,524	89,215	-	30,954	330,165
	Local Currency Cost (₱)	Direct Cost	-	153,999	307,997	363,508	-	-	825,504
		Engineering	1,053	16,443	21,474	16,737	-	-	55,507
		Administration	1,002	15,660	20,452	15,941	-	-	53,055
		Sub-total	2,055	186,102	349,923	396,186	-	--	934,266
		Contingencies	308	27,916	52,488	59,428	-	-	140,140
		Sub-total	2,368	214,018	402,411	455,614	-	-	1,074,406
		Price Escalation	2,538	318,458	799,189	1,176,851	-	-	2,297,036
		Total	4,901	532,476	1,201,600	1,632,465	-	-	3,371,442
		GRAND TOTAL (₱)	92,313	1,123,603	2,098,031	2,301,578	-	232,155	5,847,680

Fig. 8-1 Procedure of Cost Estimates for Transmission Line Work

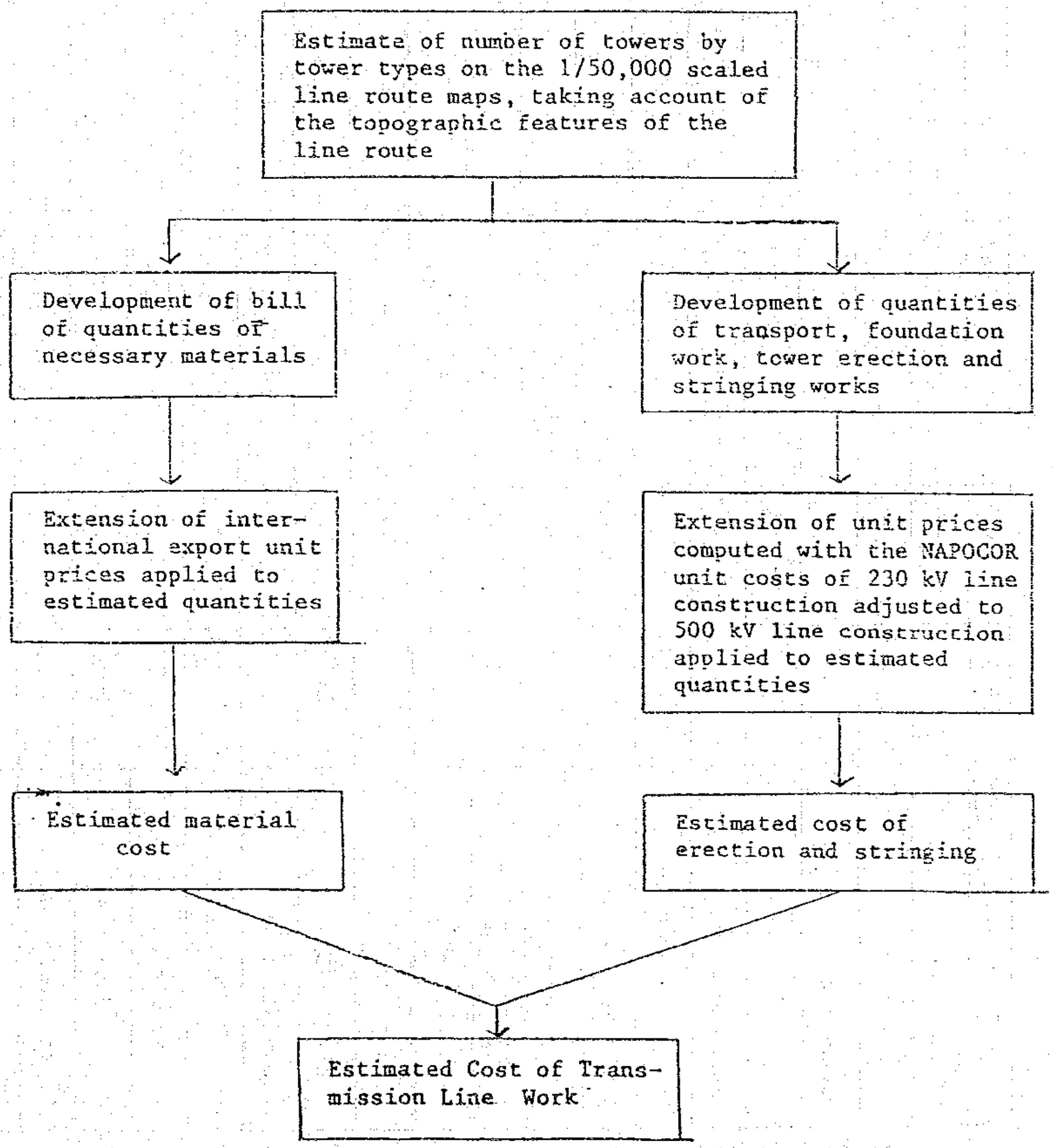
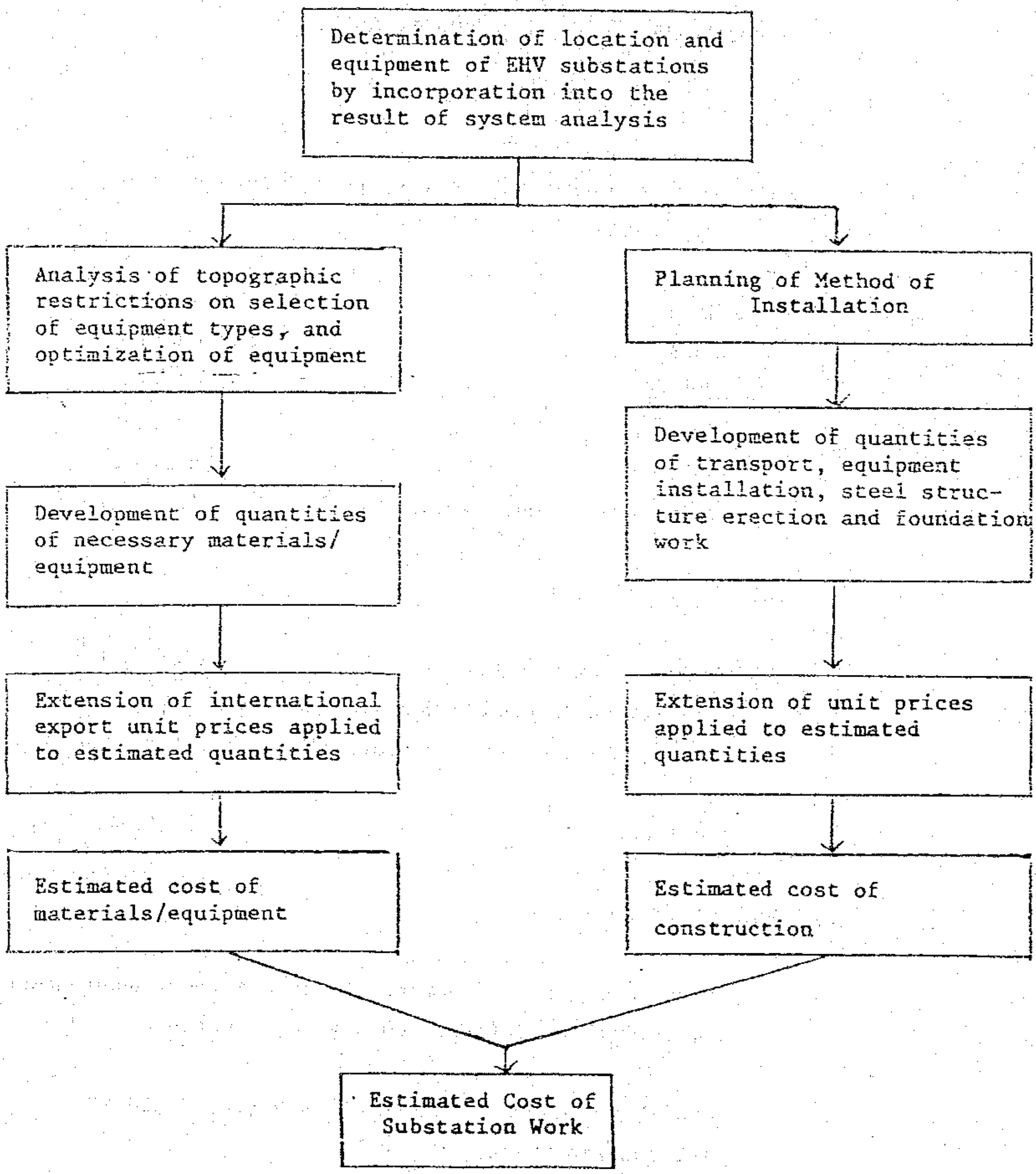


Fig. 8-2 Procedure of Cost Estimates for Substation Work



9. ECONOMIC AND FINANCIAL ANALYSIS

9.1. Economic Analysis

9.1.1. Basic Assumptions Used for Economic Analysis

(1) Cost (₱ 10^3)

(a) Total construction cost without interest during construction

500 kV Projece	2,544,564
Gened	3,690,170
CFT III	1,694,160
Chico IV	1,771,030
Diduyon	2,882,000
Associated Transmission Lines	462,644

(b) Annual OM cost

Hydro power station	45.52 ₱/kW
Coal-fired thermal power station	84.07 "
Transmission line & substation	2.5% of investment cost

(c) Fuel cost 0.24 ₱/kWh

(2) Benefit (₱ 10^3)

(a) Alternative power sources and associated transmission lines without interest during construction.

Coal Fired Thermal Plants and associated 230 kV Transmission Lines (₱ 10^3)

Coal Fired Thermal Project by 1988 (Equivalent to 600 MW hydro)	3,548,325

Coal Fired Theraml Project by 1993	1,694,160
Coal Fired Thermal Project by 1994 (Equivalent to 360 MW hydro)	2,552,534
Coal Fired Thermal Project by 1995 (Equivalent to 350 MW hydro)	2,445,237
Associated Transmission Lines and Substation	887,270

(b) Annual OM cost

Coal-fired thermal power station	84.07 ₱/kW
Transmission line & substation	2.5% of investment cost

(c) Fuel cost 0.24 ₱/kWh

(d) Other conditions are the same as "Costs".

(3) Results of economic analysis

The results of economic analysis of the Project are shown on Table 9-1. This table indicates that the Project will produce an economic rate of return of 13.46%.

9.2. Financial Analysis

The financial analysis should be made, taking into account hydro power plants whose power is to be transmitted by EHV transmission line, because the Project (Transmission line project) will not generate any revenue for itself.

9.2.1. Project (500 kV Transmission Line)

(1) Disbursement schedule of capital cost

The disbursement schedule of the capital cost with cost escalation is shown on Table 9-2. The foreign currency requirement is estimated at US$ 312,717 x 10^3 (₱2,345,378 x 10^3) and the local currency Pesos 3,371,442 x 10^3, which amount to Pesos 5,716,820 x 10^3. The cost will be disbursed from 1984 to 1989.

(2) Condition of loan of foreign exchange cost

The financing sources of the foreign exchange cost are not decided yet. But the following assumptions were used for the financial analysis.

(a) Rate of interest per annum is 3%.

(b) Period of repayment is 30 years including a grace period of 10 years.

(c) Repayment will be made in equal installments.

(3) Interest during construction of foreign loan

As shown on Table 9-3, the interest during construction is estimated at Pesos 130,856 x 10^3.

(4) Principal repayment and interest payment after start of commercial operation

Principal repayment and interest payment of the Project after start of commercial operation are shown in Table 9-4.

9.2.2. Power Plants

(1) Technical data of power plants

(a) Staging and sequence of development

Name	Capacity	Completion
Gened	600 MW	1988
CFT III	300 MW	1993
Chico IV	360 MW	1994
Diduyon	350 MW	1995

(b) Annual energy production

1988	1,153 GWH	Gened
1993	1,989 "	CFT III
1994	804 "	Chico IV
1995	950 "	Diduyon

(c) Annual administration cost

Hydro power station	13.20 ₱/kWh
Coal-fired thermal power station	24.38 "

(d) Fuel cost

0.24 Pesos/kWh

(2) Disbursement schedule of capital costs

The disbursement schedule of the capital costs including related transmission lines as shown on 9.2.3 with cost escalation is shown on Table 9-5. The foreign currency requirement is estimated at US\$ 1,393,312.5 x 10^3 (₱ 10,449,844) and the local currency Pesos 31,753,095 x 10^3, which amount to Pesos 42,202,939 x 10^3. The costs will be disbursed from 1981 to 1994.

(3) Condition of loan of foreign exchange cost

The following assumptions were used for the financial analysis.