THE REPUBLIC OF THE PHILIPPINES

REPORT ON CAGAYAN VALLEY ELECTRIFICATION PROJECT

(APPENDIX)

SEPTEMBER 1974

JAPAN INTERNATIONAL COOPERATION AGENCY

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CONTENTS

APPENDIX A-1

TEMPORARY ELECTRIFICATION SCHEME FOR IRRIGATION

Appendix

A-1 Temporary Electrification Scheme for Irrigation

A-1-1 Objectives

The Government of the Philippines has been exerting its utmost to self-reliance in production of rice which is a staple food for Philippine people as one of its highest priority policies in order to depart from the present situation of depending upon foreign countries for a considerable quantity of rice and for the purpose of coping with demand for this food due to annual increase in her population which is exceeding one million.

Because of the above background, it is the ardent desire of NEA that electrification of the Cagayan Valley for irrigation be materialized as soon as practicable. Bearing this necessity in mind, the Team has studied the Cagayan Valley Electrification Project with a view to minimization of a construction period which will be allowable from a technical point of view.

During the stay of the Team in Manila, NEA expressed its desire to erect large diesel power plants whose manufacture and delivery can be made in a short period of time, at three site and to construct 69 kV transmission lines and receiving substations as well as distribution lines as a temporary measure for acceleration of electrification for irrigation in the Valley up to the beginning of 1978 when the Cagayan Transmission Line and Substation Scheme is scheduled to be commissioned.

The temporary electrification scheme pivoted on erection of the above-mentioned diesel power plants has been worked out lest useless investment should be made to construction of transmission lines, substations and distribution lines prior to completion of the Cagayan Valley Electrification Project although the above-mentioned diesel power plants will be used for temporary purpose. Elaborate consideration was also bestowed on effective utilization of the transmission lines, substations and distribution lines to be constructed under this temporary scheme even after completion of the Cagayan Valley Electrification Project with a view to prevention of possible double investment.

A-1-2 Outline of Equipment and Facilities

A large-scale generating complex composed of many diesel power plants is to be erected in Solano, Santiago and Tuguegarao. And 69 kV transmission lines and receiving substations that are the same as those described in this report will be constructed. If the transformation facilities given in 5-2-2, i.e. 13.2 kV/69 kV step-up equipment is to be installed in Solano, Santiago and Tuguegarao while equipment at Ilagan, Cauayan and Camalaniugan Substations is to be the same as that stated in this report, the temporary diesel power plants for this temporary scheme are given hereunder.

2 units of diesel power plants with an installed capacity of 3 MW each	At Solano
5 units of diesel power plants with an installed capacity of 3 MW each	At Santiago
4 units of diesel power plants with an installed capacity of 3 MW each	At Tuguegarao

Relation between the Cagayan Transmission Line and Substation Scheme and the temporary electrification scheme is as given in Fig.A-1-1.

A-1-3 Construction Cost

The breakdown of the construction cost of this temporary electrification scheme in the respective currency portions is as follows:

(In Thousand U.S. Dollars)

Items		Foreign Currency	Domestic Currency	Total
Diesel Power Plants	(11 units)	8,760	1,800	10,560
69 Transmission Lines	(140 km)	1,430	1,220	2,650
Substations	(6 sites)	2,670	360	3,030
Distribution Lines		3,700	1,940	5,640
Total		16,560	5,320	21,880

Refer to Table 5-10 in the report for the particulars of the construction cost of diesel power plants described in the report. The total construction cost of the 69 kV transmission lines has been tabulated by adding their indirect costs to their direct costs given in Table 5-3.

That of the distribution lines is as shown in Table 6-2.

A-1-4 Power Cost of Diesel Power Plants (for Temporary Purpose) and Salable Energy Rate at the Consumer's End

Power cost and salable energy rate at the consumer's end under the temporary electrification scheme have been obtained by multiplication of the construction cost by the annual cost rate given in Table 5-9. As a result, 51.9 mills per kWh and 59.2 mills per kWh have been tabulated as power cost and salable energy rate at the consumer's end. The latter is approximately two times as expensive as the salable energy rate of 29.3 mills per kWh at the consumer's end which will be made available in 1978 upon the commissioning of the Cagayan Valley Electrification Project.

A-1-5 Constrution Schedule

The period required for order and delivery of the diesel power plants is estimated to be 10 months. In addition, if the period of their erection at the site is to be 4 months and that of constructing the transmission lines, receiving substations and distribution lines under this scheme is assumed to be the same as those given in Fig. A-1-2, it is estimated that this temporary electrification scheme will be completed at the end of 1976, which is one year earlier than the completion date of the proposed Cagayan Valley Electrification Project. The construction schedule of this scheme is as shown in Fig. A-1-2.

A-1-6 Comments

As stated before, power transmission by erection of the diesel power plants is to be commenced only one year before completion of the Cagayan Valley Electrification Project.

It will be considered possible to transfer such diesel power plants to other places. Nevertheless, various expenditures will be required from their disassembly, transport, installation and foundation construction at new sites which will amount to about 30% of the total construction cost of the diesel power plants shown in A-1-3. It is believed that investment for this purpose is not sound.

For the above reasons, after careful evaluation of merits and demerits of this temporary electrification scheme to hasten the commencement date of electrification for irrigation in the Valley by one year, compared with the commissioning of the Cagayan Valley Electrification Project, it is essential that the Government of the Philippines decide on its policy concerning electrification measures for irrigation in the Valley.

Fig. A-1-1 Temporary Electrification Scheme in Cagayan Valley.

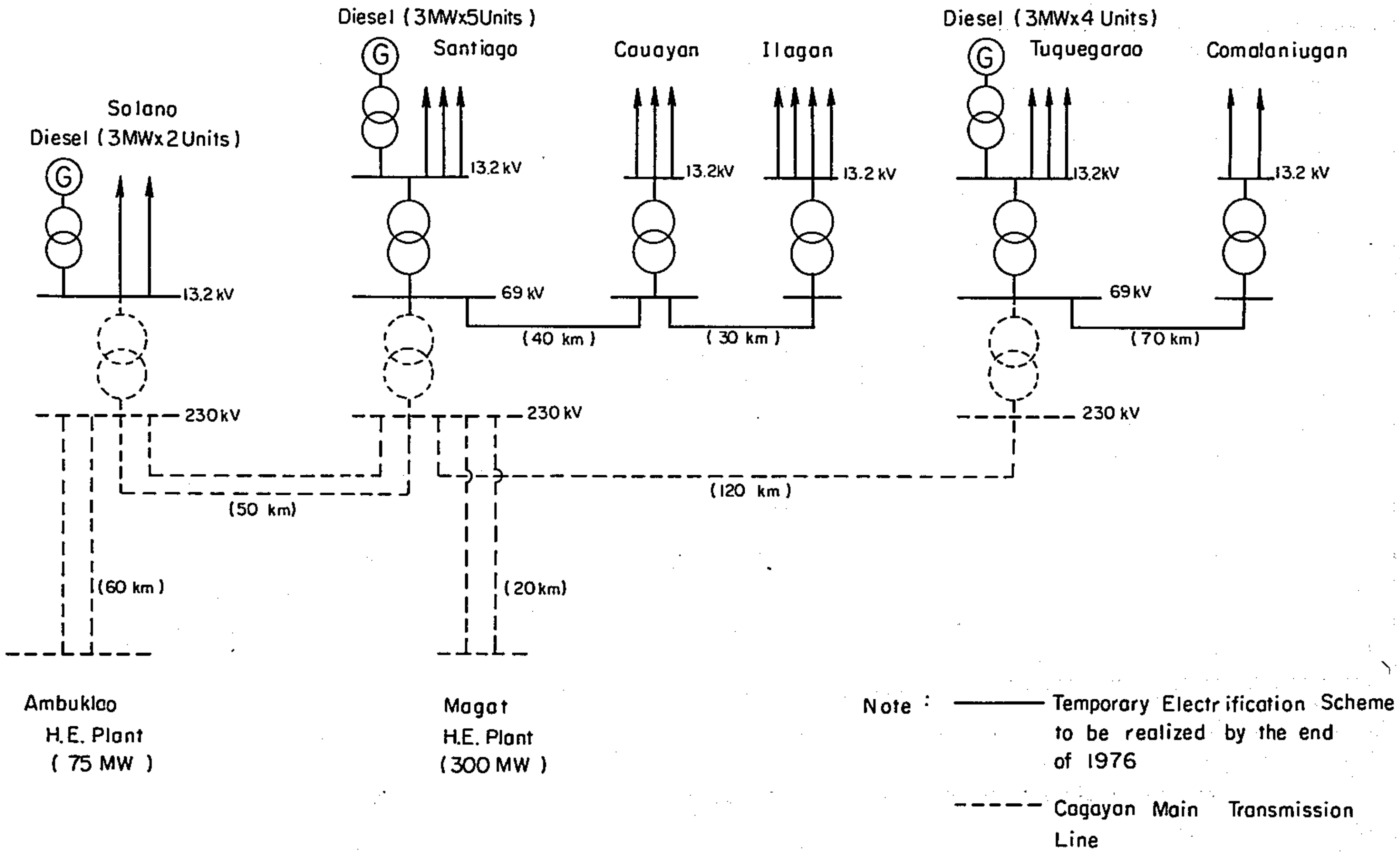
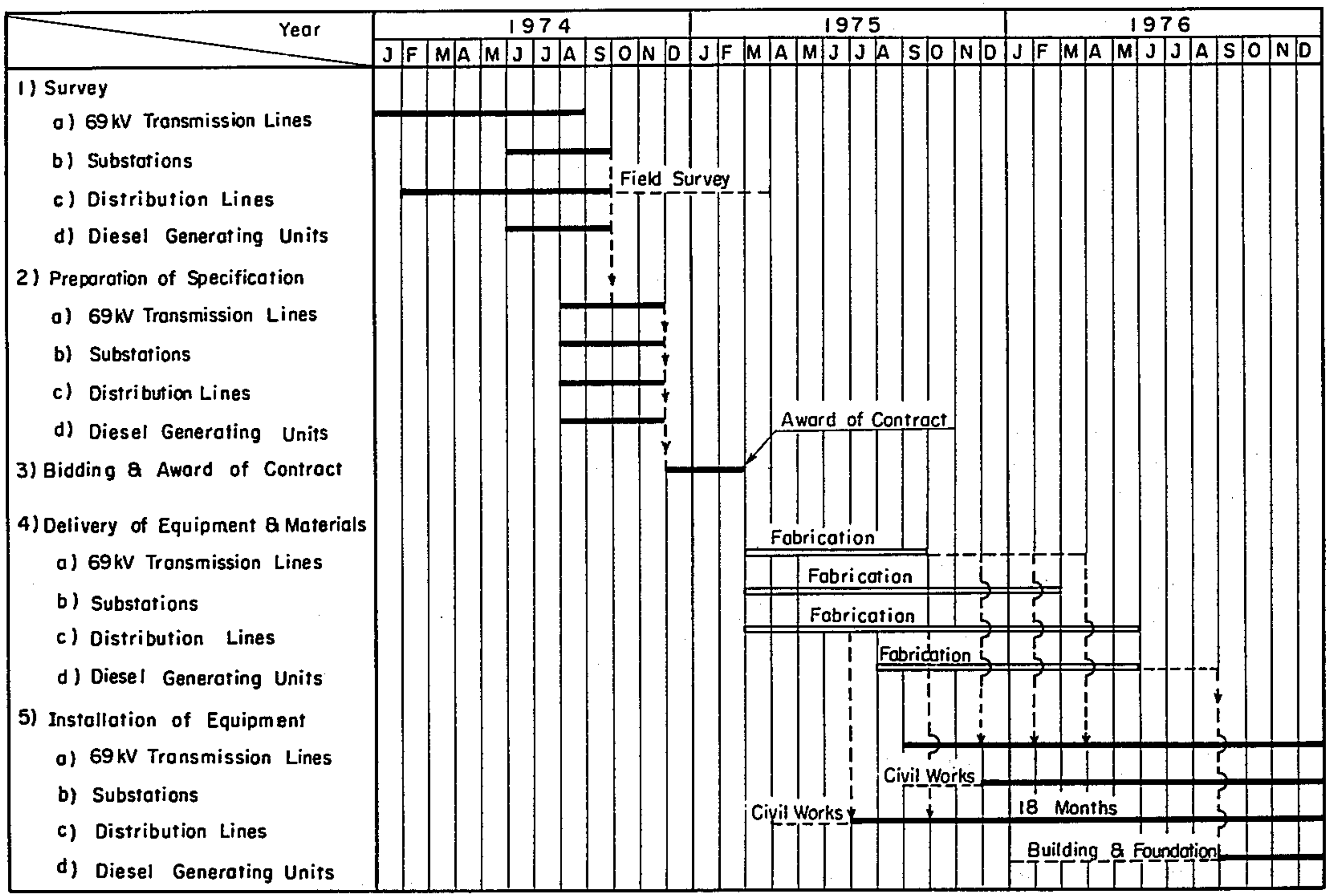


Fig. A-1-2 Temporary Electrification Scheme in Cagayan Valley



APPENDIX A-2

DEMAND FORECAST

Table A-2-1 Forecast on Power Demand by Substations

		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
(1) Solano											
Urban	(MWh)	3,386	3,832	4,338	4,911	5,559	6,349	6,856	7,405	7,997	8,627
Rural	(MWh)	0	1,272	1,908	2,544	3,180	4,109	5,038	5,967	6,896	7,827
Non-utility	(MWh)	6,528	6,998	7,500	8,035	8,622	9,237	9,902	10,621	11,384	12,206
Irrigation	(MWh)	3,850	3,916	3,960	4,026	4,092	4,180	4,224	4,290	4,356	4,400
Total		13,764	16,018	17,706	19,516	21,453	23,875	26,020	28,283	30,633	33,060
Energy requirement at substation end	(MWh)	15,293	17,797	19,673	21,684	23,836	26,527	28,911	31,425	34,036	36,733
Load factor	(%)	52	52	51	51	50	50	49	49	48	48
Max. demand	(MW)	3.4	3.9	4.4	4.9	5.4	6.1	6.7	7.3	8.1	8.7
(2) Santiago											
Urban	(MWh)	4,024	4,788	5,698	6,781	8,069	9,593	10,389	11,251	12,185	13.212
Rural	(MWh)	0	1,929	2,894	3,859	4,824	6,244	7,664	9,084	10,504	11,924
Non-utility	(MWh)	9,123	9,779	10,482	11,230	12,048	12,909	13,839	14,861	15,910	17,056
Irrigation	(MWh)	5,500	5,588	5,720	5,764	5,874	5,940	6,050	6,160	6,248	6,314
Total		18,647	22,084	24,794	27,634	30,815	34,686	37,942	41,356	44,847	48,506
Energy requirement at substation end	(MWh)	20,718	24,537	27,548	30,704	34,238	38,540	42,157	45,951	49,830	53,895
Load factor	(%)	52	51	50	50	49	48	48	47	47	47
Max. demand	(MW)	4.5	5.5	6.3	7.0	8.0	9.2	10.0	11.2	12.1	13.1
(3) Cauayan											
Urban	(MWh)	1,360	1,672	2,057	2,530	3,112	3,703	4,039	4,407	4,808	5,231
Rural	(MWh)	0	742	1,114	1,486	1,857	2,431	3,005	3,579	4,153	4,727
Non-utility	(MWh)	5,404	5,793	6,209	6,652	7,137	7,646	8,197	8,786	9,424	10,104
Irrigation	(MWh)	5,610	5,676	5,786	5,852	5,940	6,050	6,160	6,248	6,314	6,380
Total		12,374	13,883	15,166	16,520	18,046	19,830	21,401	23,020	24,699	26,442

(continued)

		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Energy requirement at substation end	(MWh)	13,748	15,425	16,851	18,355	20,051	22,033	23,778	25,577	27,443	29,380
Load factor	(%)	53	53	52	52	51	51	50	50	49	49
Max. demand	(MW)	3.0	3.3	3.7	4.0	4.5	4.9	5.4	5.8	6.3	6.8
(4) Ilagan											
Urban	(MWh)	2,294	2,844	3,527	4,373	5,423	5,760	6,238	6,755	7,316	7,922
Rural	(MWh)	0	1,152	1,728	2,304	2,881	3,733	4,585	5,437	6,289	7,144
Non-utility	(MWh)	6,528	6,998	7,500	8,035	8,622	9,237	9,902	10,634	11,384	12,206
Irrigation	(MWh)	9,240	9,328	9,504	9,592	9,724	9,856	10,010	10,120	10,274	10,384
Total		18,062	20,322	22,259	24,304	26,650	28,586	30,735	32,946	35,263	37,656
Energy requirement at substation end	(MWh)	20,068	22,580	24,732	27,004	29,611	31,762	34,150	36,606	39,181	41,840
Load factor	(%)	53	53	53	52	52	51	51	50	50	50
Max. demand	(MW)	4.3	4.9	5.3	5.9	6.5	7.1	7.6	8.4	8.9	9.6
(5) Tuguegarao											
Urban	(MWh)	4,346	5,023	5,807	6,713	7,761	9,032	9,736	10,495	11,314	12,195
Rural	(MWh)	0	1,809	2,714	3,619	4,524	5,825	7,126	8,427	9,728	11,032
Non-utility	(MWh)	7,653	8,204	8,793	9,420	10,107	10,834	11,612	12,441	13,341	14,308
Irrigation	(MWh)	9,240	9,350	9,438	9,482	9,570	9,658	9,746	9,812	9,878	9,966
Total		21,239	24,386	26,752	29,234	31,962	35,349	38,220	41,175	44,261	47,501
Energy requirement at substation end	(MWh)	23,598	27,095	29,724	32,482	35,513	39,276	42,466	45,750	49,178	52,778
Load factor	(%)	52	52	52	51	51	50	50	50	49	49
Max. demand	(MW)	5.2	5.9	6.5	7.2	7.9	8.9	9.7	10.4	11.5	12.3

(continued)

		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
(6) Camalaniugan											
Urban	(MWh)	1,183	3,149	3,999	5,079	6,450	8,105	8,729	9,401	10,125	10,914
Rural	(MWh)	0	1,630	2,445	3,260	4,077	5,236	6,395	7,554	8,713	9,876
Non-utility	(MWh)	7,999	8,574	9,190	9,846	10,563	11,318	12,134	13,006	13,950	14,955
Irrigation	(MWh)	3,080	3,124	3,168	3,212	3,234	3,322	3,366	3,432	3,476	3,630
Total		12,262	16,477	18,802	21,397	24,324	27,981	30,624	33,393	36,264	39,375
Energy requirement at substation end	(MWh)	13,624	18,307	20,891	23,774	27,026	31,090	34,026	37,103	40,293	43,750
Load factor	(%)	50	50	50	49	48	47	47	46	46	46
Max. demand	(MW)	3.1	4.2	4.8	5.5	6.4	7.6	8.3	9.2	10.0	10.9
(7) Cagayan Valley											
Max. demand	(MW)	23.5	27.7	31.0	34.5	38.7	43.8	47.7	52.3	56.9	61.4
Energy requirement	(MWh)	107,049	125,741	139,419	154,003	170,275	189,228	205,488	222,412	239,961	258,376

Note: Annual energy requirement for irrigation has been tabulated on the assumption that the operation hours of pumps are to be 2,200 hours per year.

A-2-2 Area and Power Demand of Proposed Irrigation Pump Projects by Substations

Table A-2-2 Area and Power Demand of Proposed Irrigation Pump Projects by Substations

(As of 1978)

Substation	Irrigation Area in ha. (Number of projects)				Power Demand in kW (Number of units)			
	National I.P.	Communal I.P.	Private I.P.1/	Total	National I.P.	Communal I.P.	Private I.P.1/	Total
Solano	-	3,775 (24)	825	4,600	-	1,427 (71)	323	1,750
Santiago	-	4,418 (22)	982	5,400	-	2,046 (79)	454	2,500
Cauayan	-	4,140 (17)	860	5,000	-	2,082 (81)	468	2,550
Ilagan	2,000 2/ (1)	6,290 (24)	1,410	9,700	520 (4)	3,004 (112)	676	4,200
Tuguegarao	5,730 3/ (2)	4,297 (28)	973	11,000	2,050 (9)	1,770 (90)	380	4,200
Camalaniugan		2,570 (13)	530	3,100	-	1,144 (48)	256	1,400
Total	7,730 (3)	25,490 (128)	5,580	38,800	2,570 (13)	11,473 (481)	2,557	16,600
							Say	16.6 MW

Note:

1/ implies the project area and power demand of private irrigation projects which are estimated to be approximately 20% of those of communal irrigation projects.

2/ indicates Magsaysay Pump Irrigation Project.

3/ indicates Solana - Tuguegarao and Pared River Pump Irrigation Projects.

(continued)

(As of 1982)

Substation	Irrigation Area in ha. (Number of projects)				Power Demand in kW (Number of units)			
	National I.P	Communal I.P.	Private I.P. 1/	Total	National I.P.	Communal I.P.	Private I.P. 1/	Total
Solano	-	3,775 (24)	1,125	4,900	-	1,427 (71)	433	1,860
Santiago	-	4,418 (22)	1,282	5,700	-	2,046 (79)	624	2,670
Cauayan	-	4,140 (17)	1,260	5,400	-	2,082 (81)	618	2,700
Ilagan	2,000 (1)	6,290 (24)	1,910	10,200	520 (4)	3,004 (112)	896	4,420
Tuguegarao	5,730 (2)	4,297 (28)	1,273	11,300	2,050 (9)	1,770 (90)	530	4,350
Camalaniugan	-	2,570 (13)	730	3,300		1,144 (48)	326	1,470
Total	7,730 (3)	25,490 (128)	7,580	40,800	2,570 (13)	11,473 (481)	3,427	17,470
								Say 17.5 MW

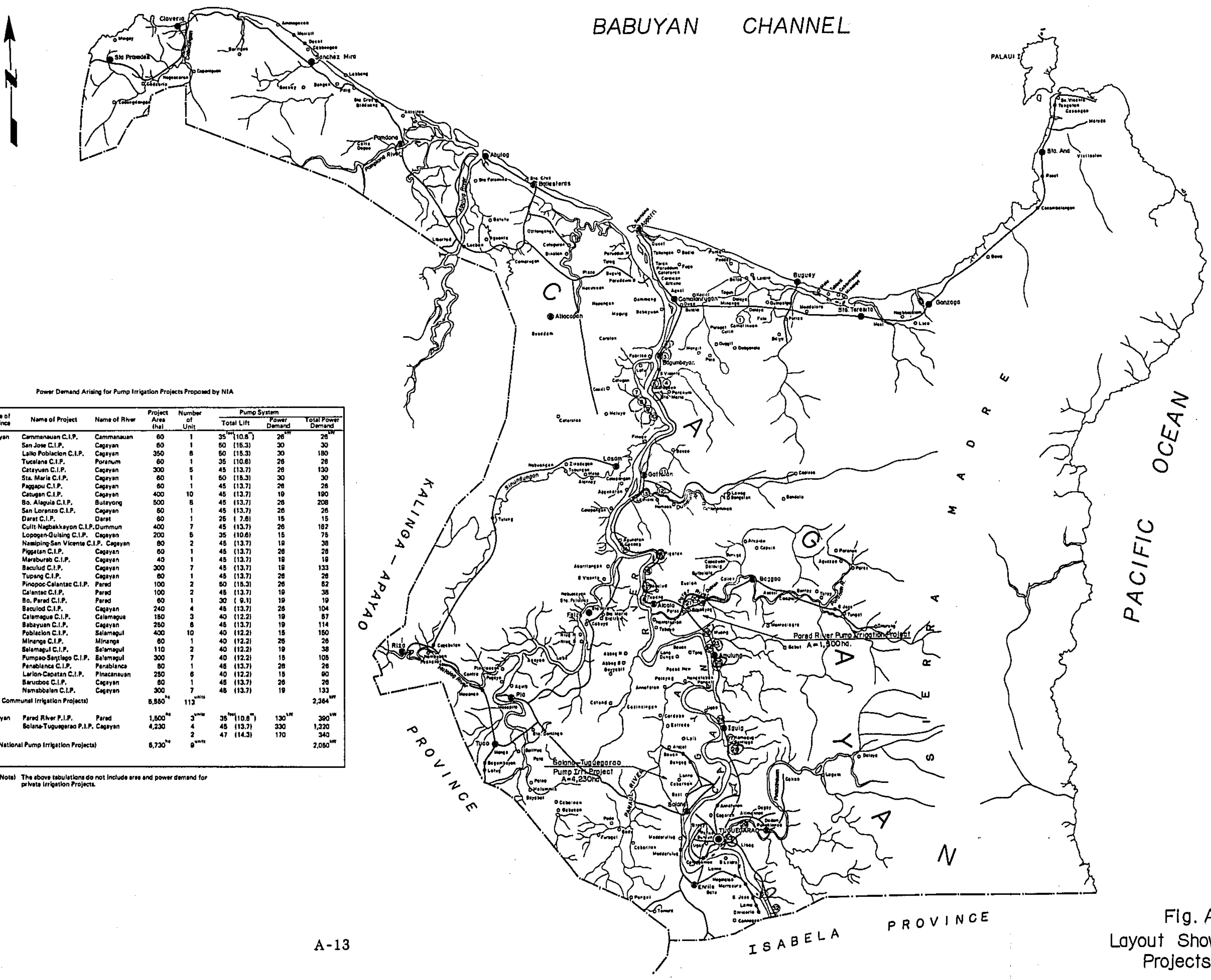
Note: 1/ implies the project area and power demand of private irrigation projects, which are estimated to be approximately 30% of those of communal irrigation projects.

(continued)

(As of 1987)

Substation	Irrigation Area in ha. (Number of projects)				Power Demand in kW (Number of units)			
	National I.P.	Communal I.P.	Private I.P. 1/	Total	National I.P.	Communal I.P.	Private I.P. 1/	Total
Solano	-	3,775 (24)	1,525	5,300	-	1,427 (71)	573	2,000
Santiago	-	4,418 (22)	1,782	6,200	-	2,046 (79)	824	2,870
Cauayan	-	4,140 (17)	1,660	5,800	-	2,082 (81)	818	2,900
Ilagan	2,000 (1)	6,290 (24)	2,510	10,800	520 (4)	3,004 (112)	1,196	4,720
Tuguegarao	5,730 (2)	4,297 (28)	1,773	11,800	2,050 (9)	1,770 (90)	710	4,530
Camalaniugan	-	2,570 (13)	1,030	3,600	-	1,144 (48)	506	1,650
Total	7,730 (3)	25,490 (128)	10,280	43,500	2,570 (13)	11,473 (481)	4,627	18,670
								Say 18.7 MW

Note: 1/ implies the project area and power demand of private irrigation projects, which are estimated to be approximately 40% of those of communal irrigation projects.

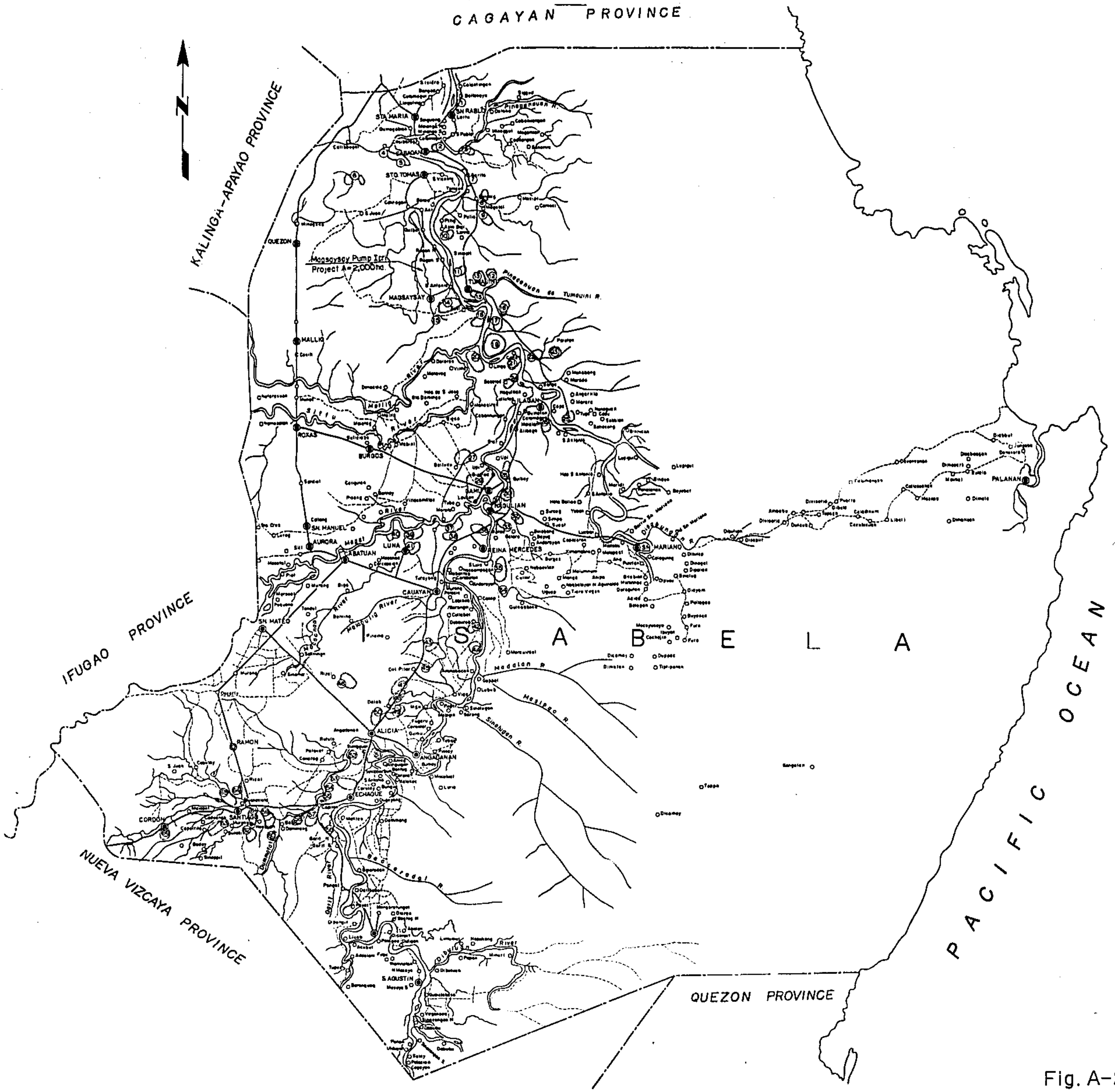


Power Demand Arising for Pump Irrigation Projects Proposed by NIA

Number of Project	Name of Province	Name of Project	Name of River	Project Area (ha)	Number of Unit	Pump System: Total Lift	Pump System: Power Demand	Pump System: Total Power Demand
1	Cagayan	Cammanauan C.I.P.	Cammanauan	60	1	35[feet] (10.8[m])	26[kW]	26[kW]
2		San Jose C.I.P.	Cagayan	60	1	50 (15.3)	30	30
3		Lallo Poblacion C.I.P.	Cagayan	350	6	50 (15.3)	30	180
4		Tucalana C.I.P.	Poranum	60	1	35 (10.6)	26	26
5		Catayuan C.I.P.	Cagayan	300	5	45 (13.7)	26	130
6		Sta. Maria C.I.P.	Cagayan	60	1	50 (15.3)	30	30
7		Paggapu C.I.P.	Cagayan	60	1	45 (13.7)	26	26
8		Catugan C.I.P.	Cagayan	400	10	45 (13.7)	19	190
9		Bo. Alaguia C.I.P.	Butayong	500	8	45 (13.7)	26	208
10		San Lorenzo C.I.P.	Cagayan	60	1	45 (13.7)	26	26
11		Darat C.I.P.	Darat	60	1	25 (7.6)	15	15
12		Culit-Nagbakkayon C.I.P.	Dummun	400	7	45 (13.7)	26	182
13		Lopogan-Guising C.I.P.	Cagayan	200	5	35 (10.6)	15	75
14		Nassiping-San Vicente C.I.P.	Cagayan	80	2	45 (13.7)	19	38
15		Piggatan C.I.P.	Cagayan	60	1	45 (13.7)	26	26
16		Maraburab C.I.P.	Cagayan	40	1	45 (13.7)	19	19
17		Baculud C.I.P.	Cagayan	300	7	45 (13.7)	19	133
18		Tupang C.I.P.	Cagayan	60	1	45 (13.7)	26	26
19		Pinopoc-Calantac C.I.P.	Pared	100	2	50 (15.3)	26	52
20		Calantac C.I.P.	Pared	100	2	45 (13.7)	19	38
21		Bo. Pared C.I.P.	Pared	60	1	30 (9.1)	19	19
22		Baculod C.I.P.	Cagayan	240	4	45 (13.7)	26	104
23		Calamagua C.I.P.	Calamagua	150	3	40 (12.2)	19	57
24		Babayuan C.I.P.	Cagayan	250	6	45 (13.7)	19	114
25		Poblacion C.I.P.	Salamagui	400	10	40 (12.2)	15	150
26		Minanga C.I.P.	Minanga	60	1	40 (12.2)	26	26
27		Salamagui C.I.P.	Salamagui	110	2	40 (12.2)	19	38
28		Pumpao-Santiago C.I.P.	Salamagui	300	7	40 (12.2)	15	105
29		Penablanca C.I.P.	Penablanca	60	1	45 (13.7)	26	26
30		Larion-Capatan C.I.P.	Pinacanauan	250	6	40 (12.2)	15	90
31		Barucboc C.I.P.	Cagayan	60	1	45 (13.7)	26	26
32		Namabbalan C.I.P.	Cagayan	300	7	45 (13.7)	19	133
Subtotal (32 Communal Irrigation Projects)				5,550[ha]	113[units]			2,364[kW]
	Cagayan	Pared River P.I.P.	Pared	1,500[ha]	3[units]	35[feet] (10.8[m])	130[kW]	390[kW]
		Solana-Tuguegarao P.I.P.	Cagayan	4,230	4	45 (13.7)	330	1,320
					2	47 (14.3)	170	340
Subtotal (2 National Pump Irrigation Projects)				5,730[ha]	9[units]			2,050[kW]

Note) The above tabulations do not include area and power demand for private irrigation Projects.

Fig. A-2-1 (1)
Layout Showing Pump Irrigation Projects, Cagayan Province

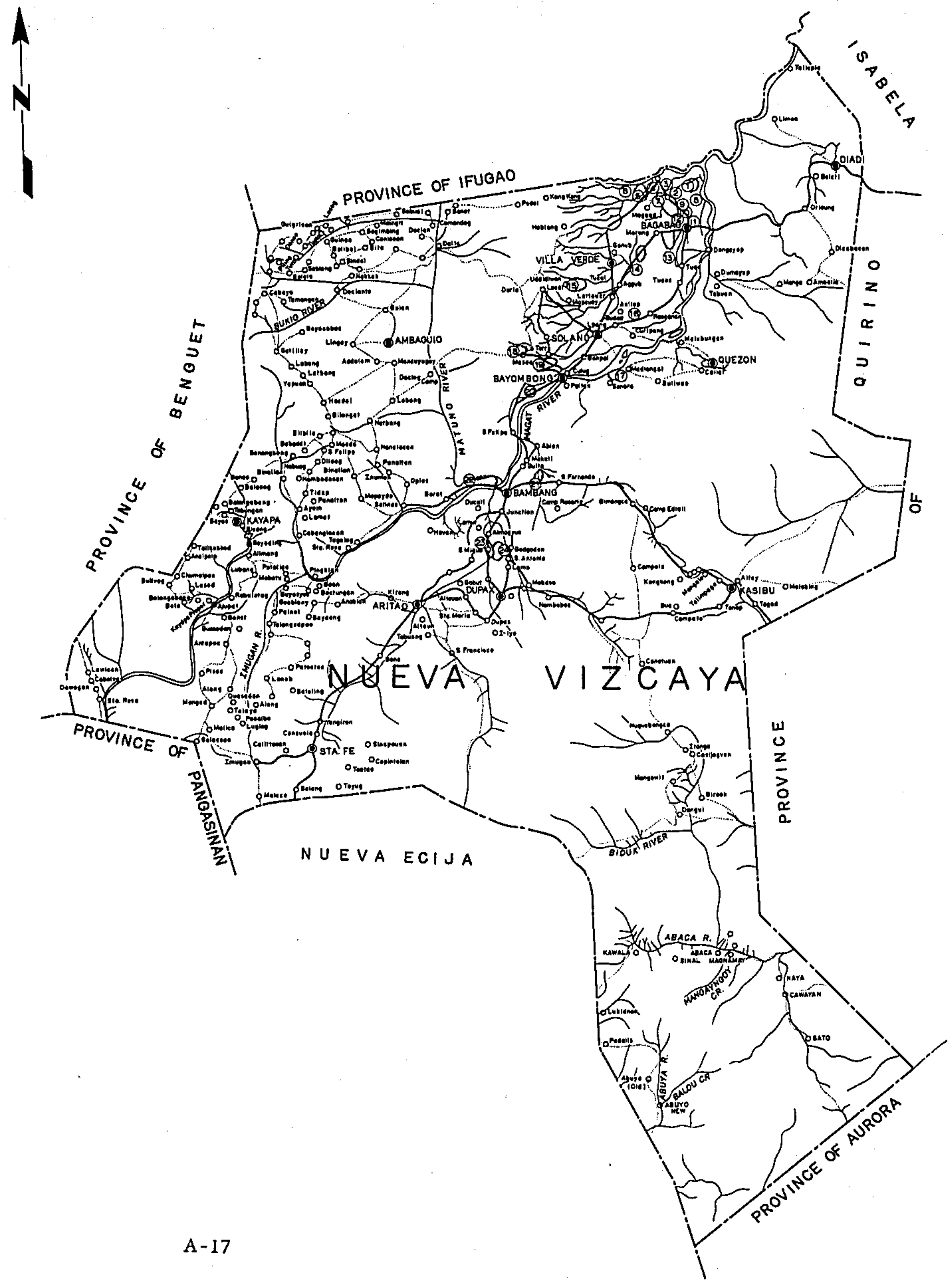


Power Demand Arising for Pump Irrigation Projects Proposed by NIA

Number of Project	Name of Province	Name of Project	Name of River	Project Area (ha)	Number of Unit	Pump System		
						Total Lift	Power Demand	Total Power Demand
1	Isabela	San Jose C.I.P.	Cagayan	180	3	40 feet (12.2 m)	26 kW	78 kW
2		Ugad C.I.P.	Pinacanauan	80	2	35 (10.7)	15	30
3		Angacasilian C.I.P.	Belluto	140	3	35 (10.7)	15	45
4		Pakulago C.I.P.	Pakulago	50	1	30 (9.1)	15	15
5		Bagueoay C.I.P.	Baguebay Lake	200	4	30 (9.1)	15	60
6		Malasi Grande C.I.P.	M. Grande	350	6	50 (15.2)	30	180
7		Censan C.I.P.	Cagayan	117	2	40 (12.2)	26	52
8		Balasig No. 1 C.I.P.	Balasig	100	2	50 (15.2)	26	52
9		Balasig No. 2 C.I.P.	Balasig	100	2	40 (12.2)	19	38
10		Lanna C.I.P.	Cagayan	60	1	40 (12.2)	26	26
11		Ugad C.I.P.	Cagayan	60	1	40 (12.2)	26	26
12		Sillo Bato C.I.P.	Pinacanauan	60	1	40 (12.2)	26	26
13		Arcon C.I.P.	Pinacanauan	500	8	40 (12.2)	26	208
14		San Antonio C.I.P.	Cagayan	1,200	21	60 (18.3)	30	630
15		Pata Lake C.I.P.	Pata Lake	100	2	50 (15.2)	26	52
16		Balog Paoay C.I.P.	Balog	100	2	40 (12.2)	19	38
17		Sto. Nino C.I.P.	Cagayan	115	2	50 (15.2)	26	52
18		Pilitan C.I.P.	Cagayan	200	4	40 (12.2)	19	76
19		Lapogan C.I.P.	Cagayan	900	15	40 (12.2)	26	390
20		Sta. Isabela C.I.P.	Cagayan	350	7	70 (21.3)	30	210
21		Canapi C.I.P.	Cagayan	70	2	35 (10.7)	15	30
22		San Juan C.I.P.	Rugao	120	3	60 (18.3)	30	90
23		Rugao C.I.P.	Rugao	50	1	50 (15.2)	26	26
24		Tabo C.I.P.	Cagayan	120	2	40 (12.2)	26	52
25		Allangigan C.I.P.	Ilagan	120	2	40 (12.2)	26	52
26		Malalam C.I.P.	Ilagan	60	1	50 (15.2)	30	30
27		Bos. of Gamu C.I.P.	Cagayan	460	8	40 (12.2)	26	208
28		Upi C.I.P.	Cagayan	125	3	80 (24.4)	30	90
29		Barrios of Gamu C.I.P.	Cagayan	1,000	16	45 (13.7)	26	416
30		Minanga C.I.P.	Caunayan	220	4	60 (18.3)	30	120
31		Poblacion C.I.P.	Cagayan	100	2	60 (18.3)	26	52
32		San Manuel C.I.P.	Anipa	100	2	50 (15.2)	26	52
33		Anipa C.I.P.	Anipa	100	2	50 (15.2)	26	52
34		Bo. Aningan C.I.P.	Caunayan	80	2	50 (15.2)	19	38
35		Caunayan C.I.P.	Caunayan	400	7	40 (12.2)	26	182
36		Palattao C.I.P.	Caunayan	120	2	40 (12.2)	26	52
37		Turod C.I.P.	Magat	350	7	70 (21.3)	30	210
38		Puzzer C.I.P.	Puzzer	200	4	70 (21.3)	26	104
39		Macanao C.I.P.	Macanao	300	6	40 (12.2)	19	114
40		Bo. #3 Luna C.I.P.	Macanao	180	3	40 (12.2)	26	78
41		Sitio Tunggi C.I.P.	Macanao	200	4	30 (9.1)	15	60
42		Sta. Lucia C.I.P.	Cagayan	200	4	30 (9.1)	15	60
43		Sillawit C.I.P.	Nungnungan	160	3	50 (15.2)	26	78
44		San Antonio C.I.P.	Cagayan	200	4	35 (10.7)	15	60
45		Sitio San Antonio C.I.P.	Alinom	60	1	40 (12.2)	26	26
46		Rizal C.I.P.	Makeokaoayan	400	8	80 (24.4)	30	240
47		Burgos C.I.P.	Paddad	300	6	80 (24.4)	30	180
48		Rizaluna C.I.P.	Paddad	400	8	80 (24.4)	30	240
49		Paddad C.I.P.	Paddad	400	8	80 (24.4)	30	240
50		Bo. Burgos C.I.P.	Paddad	200	4	80 (24.4)	30	120
51		Bo. Victoria C.I.P.	Ganano	120	2	50 (15.2)	30	60
52		Sta. Maria C.I.P.	Ganano	250	4	50 (15.2)	30	120
53		Gumbaoan C.I.P.	Ganano	500	8	50 (15.2)	30	240
54		Fugo C.I.P.	Ganano	200	4	50 (15.2)	26	104
55		Buneg C.I.P.	Ganano	178	3	50 (15.2)	30	90
56		Maligaya C.I.P.	Cagayan	300	6	50 (15.2)	26	156
57		Ipil C.I.P.	Ganano	200	4	50 (15.2)	26	104
58		Sta. Monica C.I.P.	Ganano	100	2	50 (15.2)	26	52
59		Balwarte C.I.P.	Ganano	200	4	50 (15.2)	26	104
60		Nabbuan C.I.P.	Dumatata	60	1	50 (15.2)	30	30
61		Malini C.I.P.	Ganano	300	6	50 (15.2)	26	156
62		Sinili C.I.P.	Ganano	300	6	50 (15.2)	26	156
63		Patul-Bayug C.I.P.	Ganano	500	8	50 (15.2)	30	240
64		San Andres C.I.P.	Diadi	60	1	50 (15.2)	30	30
65		Ambalatungan C.I.P.	Diadi	350	6	50 (15.2)	30	180
66		Sagat C.I.P.	Sagat	100	2	50 (15.2)	26	52
Subtotal (66 Communal Irrigation Projects)				15,466 ha	285 units			7,510 kW
	Isabela	Magsaysay P.I.P.	Cagayan	2,000 ha	4 units	35 feet (10.6 m)	130 kW	520 kW

Note) The above tabulations do not include area and power demand for Private Irrigation Projects.

Fig. A-2-1 (2)
Layout Showing Pump Irrigation Projects
Isabela Province

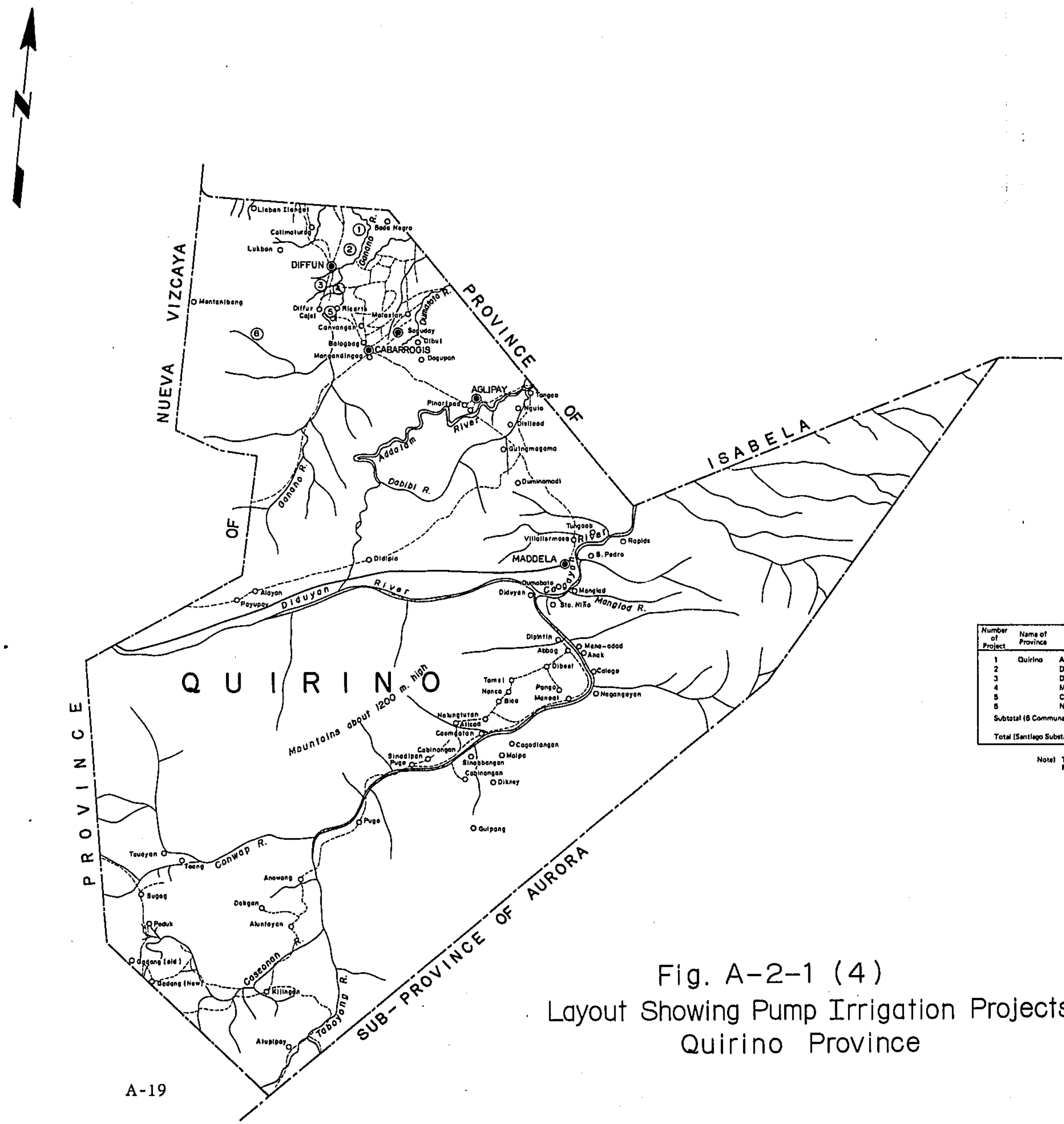


Power Demand Arising for Pump Irrigation Projects Proposed by NIA

Number of Project	Name of Province	Name of Project	Name of River	Project Area (ha)	Number of Unit	Pump System: Total Lift	Pump System: Power Demand	Pump System: Total Power Demand
1	Nueva Vizcaya	Sta. Lucia #1 C.I.P.	Sta. Lucia	100	2	35 feet (10.7 m)	15 kW	30 kW
2		Sta. Lucia #2 C.I.P.	Zamora	75	2	40 (12.2)	15	30
3		Saranay-Malasin C.I.P.	Lanog	220	4	45 (13.7)	26	104
4		Bakir C.I.P.	Lanog	50	1	25 (7.6)	11	11
5		Paniki C.I.P.	Paniki	135	3	30 (9.1)	15	45
6		Mangalisan C.I.P.	Lamut	100	2	30 (9.1)	15	30
7		Calutlutan C.I.P.	Lanog	500	8	45 (13.7)	26	208
8		Sitio Tabanganay C.I.P.	Unaon	80	2	40 (12.2)	15	30
9		Villa Reina #1 C.I.P.	Villa Reina	70	2	30 (9.1)	11	22
10		Villa Reina #2 C.I.P.	Gauan Reservoir	75	2	35 (10.7)	15	30
11		Unaon C.I.P.	Unaon	80	1	35 (10.7)	26	26
12		Sitio Unaon C.I.P.	Unaon	130	3	40 (12.2)	15	45
13		Tullag Lake C.I.P.	Tullag Lake	400	7	35 (10.7)	19	133
14		Murong C.I.P.	Lanog	300	5	35 (10.7)	26	130
15		Uddiawan C.I.P.	Uddiawan	100	2	40 (12.2)	19	38
16		Bascaran C.I.P.	Don Doro Lake	100	2	30 (9.1)	15	30
17		Madjangat C.I.P.	Magat	120	2	45 (13.7)	26	52
18		Masoc C.I.P.	Pappapa Spring	100	2	25 (7.6)	11	22
19		Paoac C.I.P.	Paoac	120	2	25 (7.6)	15	30
20		Baliwawang C.I.P.	Baliwawang	150	3	30 (9.1)	15	45
21		Domang C.I.P.	Nambunakan	250	4	35 (10.7)	26	104
22		Bafungao C.I.P.	Matuno	120	2	30 (9.1)	19	38
23		Mabessar C.I.P.	Banay	120	2	30 (9.1)	19	38
24		Almaguer C.I.P.	Banay	300	6	60 (18.3)	26	156
Subtotal (16 Communal Irrigation Projects)				3,775 ha	71 units			1,427 kW

Note) The above tabulations do not include area and power demand for private Irrigation Projects.

Fig. A-2-1 (3)
Layout Showing Pump Irrigation Projects
Nueva Vizcaya Province



Power Demand Arising for Pump Irrigation Projects Proposed by NIA by Substations

Number of Project	Name of Province	Name of Project	Name of River	Project Area (ha)	Number of Unit	Pump System		
						Total Lift	Power Demand	Total Power Demand
1	Quirino	Amilingan C.I.P.	Amilingan	120	2	25 feet (7.6 m)	15 kW	30 kW
2		Dalanap C.I.P.	Dalanap	100	2	25 (7.6)	11	22
3		Dagano C.I.P.	Ganano	60	1	25 (7.6)	15	15
4		Malayod C.I.P.	Vga. Pascua Reservoir	60	1	25 (7.6)	15	15
5		Cajal C.I.P.	Ganano	300	5	25 (7.6)	15	75
6		Nanganakan C.I.P.	Nanganakan	60	1	25 (7.6)	15	15
Subtotal (6 Communal Irrigation Projects)				700 ha	12 units			172 kW
Total (Santiago Substation—22 C.I. Projects)				4,418 ha	79 units			2,046 kW

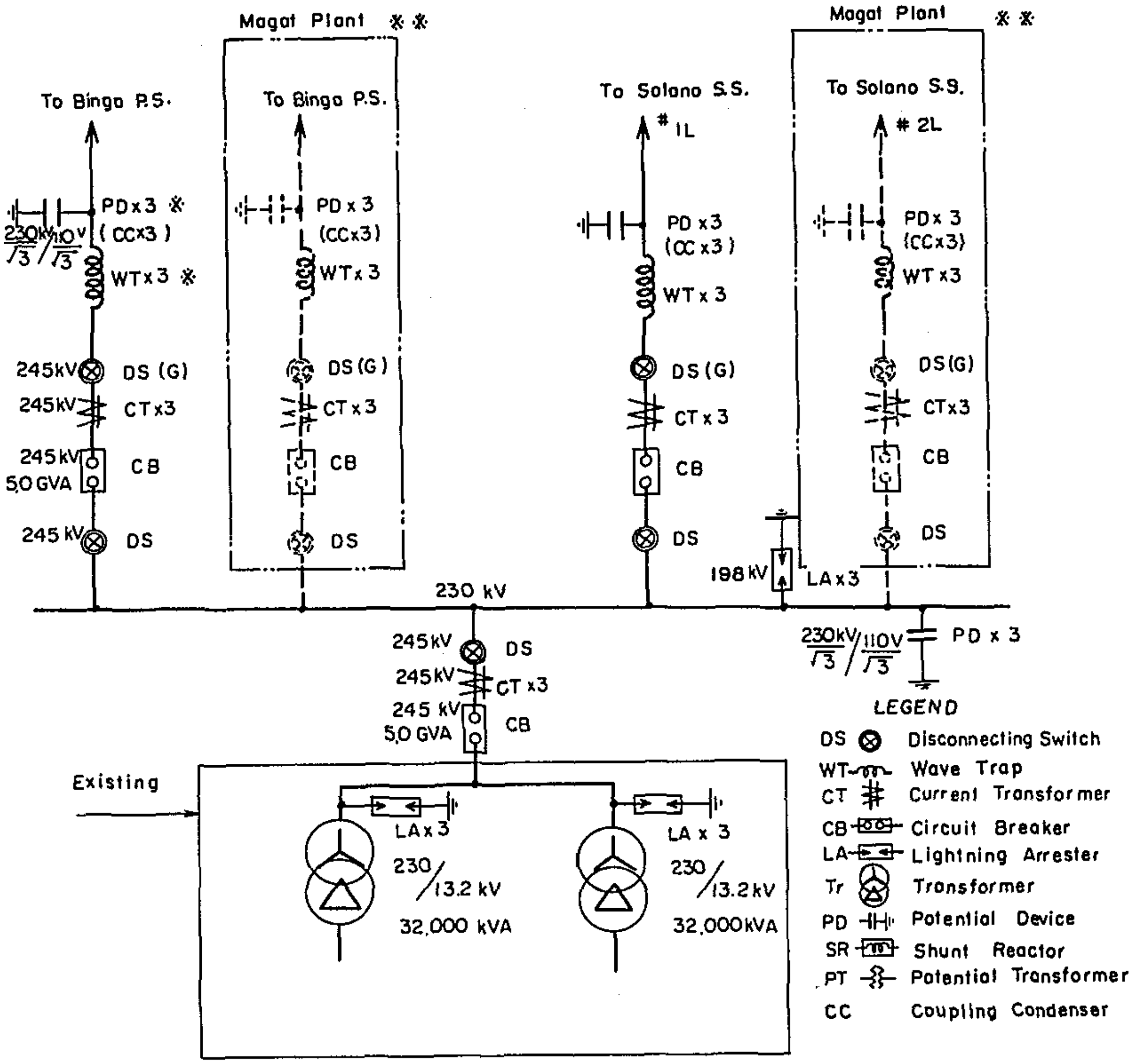
Note) The above tabulations do not include area and power demand for Private Irrigation Projects.

Fig. A-2-1 (4)
Layout Showing Pump Irrigation Projects
Quirino Province

APPENDIX A-3

CAGAYAN TRANSMISSION LINE AND SUBSTATION SCHEME

Fig.A-3-1 Skelton Diagram of Ambuklao Power Station.



Note

1. The Dott Line Indicating lines to be linked with Bingo and Solano Power Stations, respectively upon completion of Magat Power Station are not included in the proposed Project.
2. ※ Implies existing equipment which will be transfered to this power station
3. ※※ Implies upon completion of Magat Power Plant this line is to be connected with Bingo Power Station and or Solano Substation

Fig.A-3-2 Skelton Diagram of Solano Substation

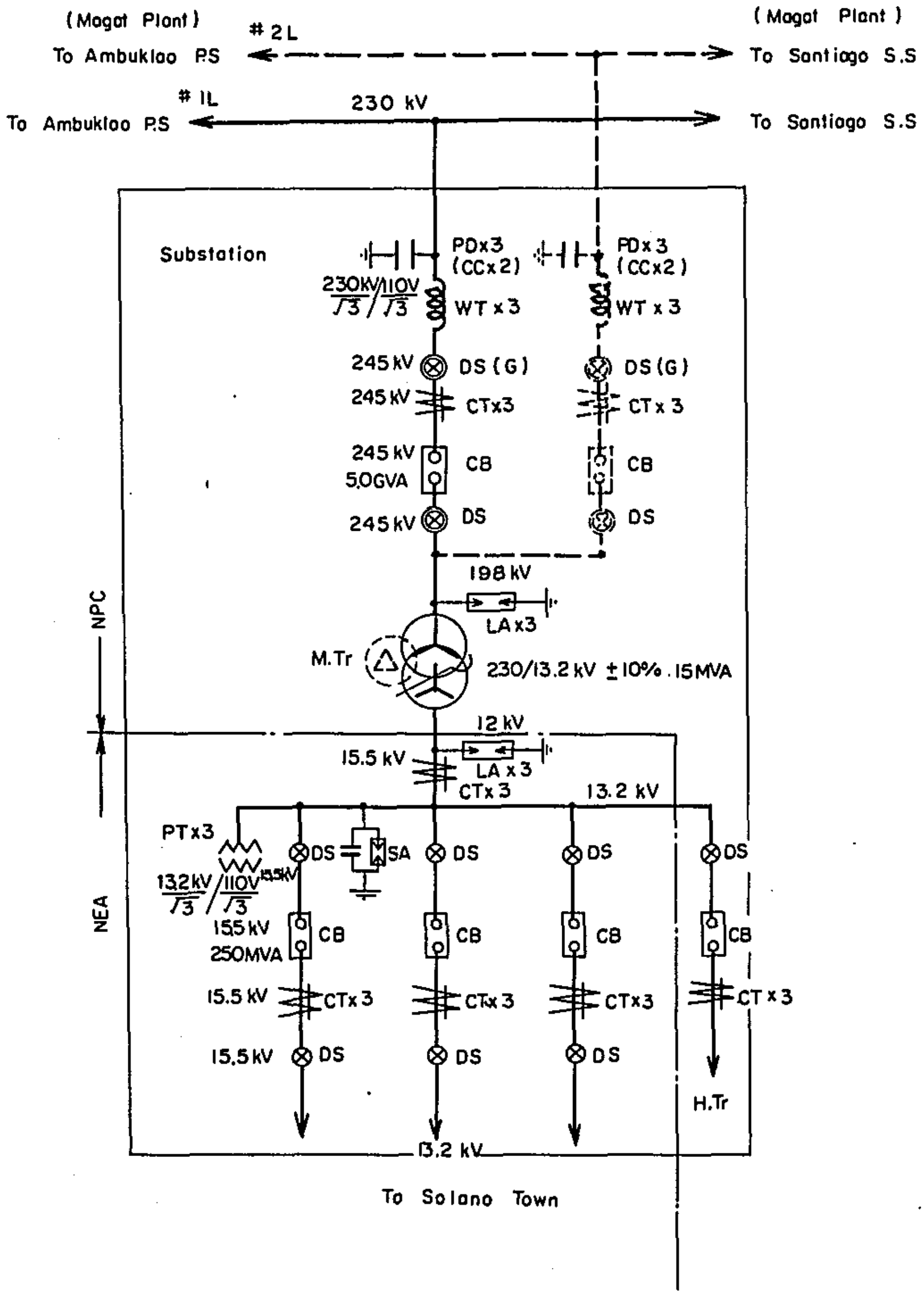
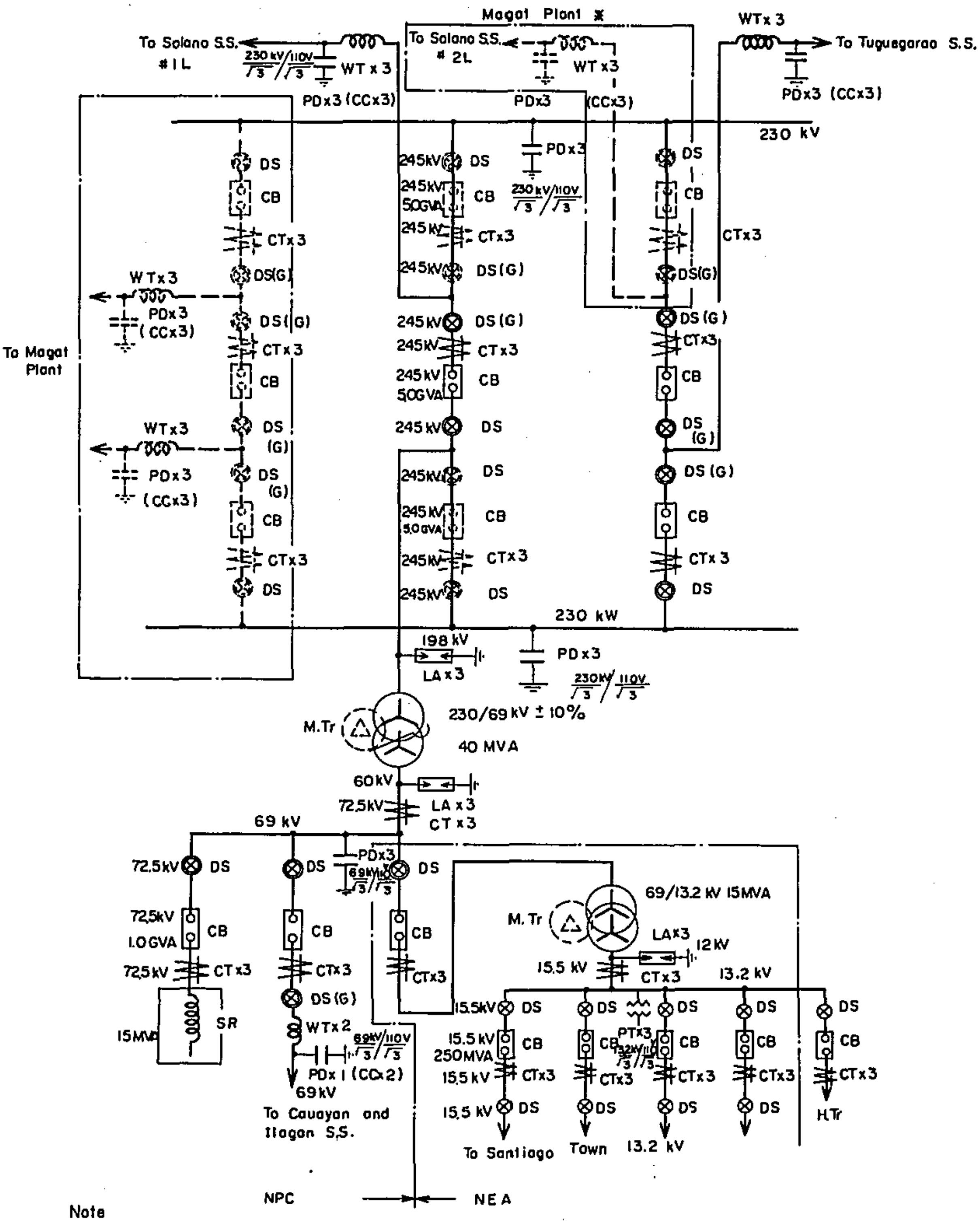


Fig.A-3-3 Skelton Diagram of Santiago Substation.



Note

※ Implies upon completion of Magat Power Plant this line is to be connected with Solano Substation.

Fig.A-3-4 Skelton Diagram of Tuguegarao Substation.

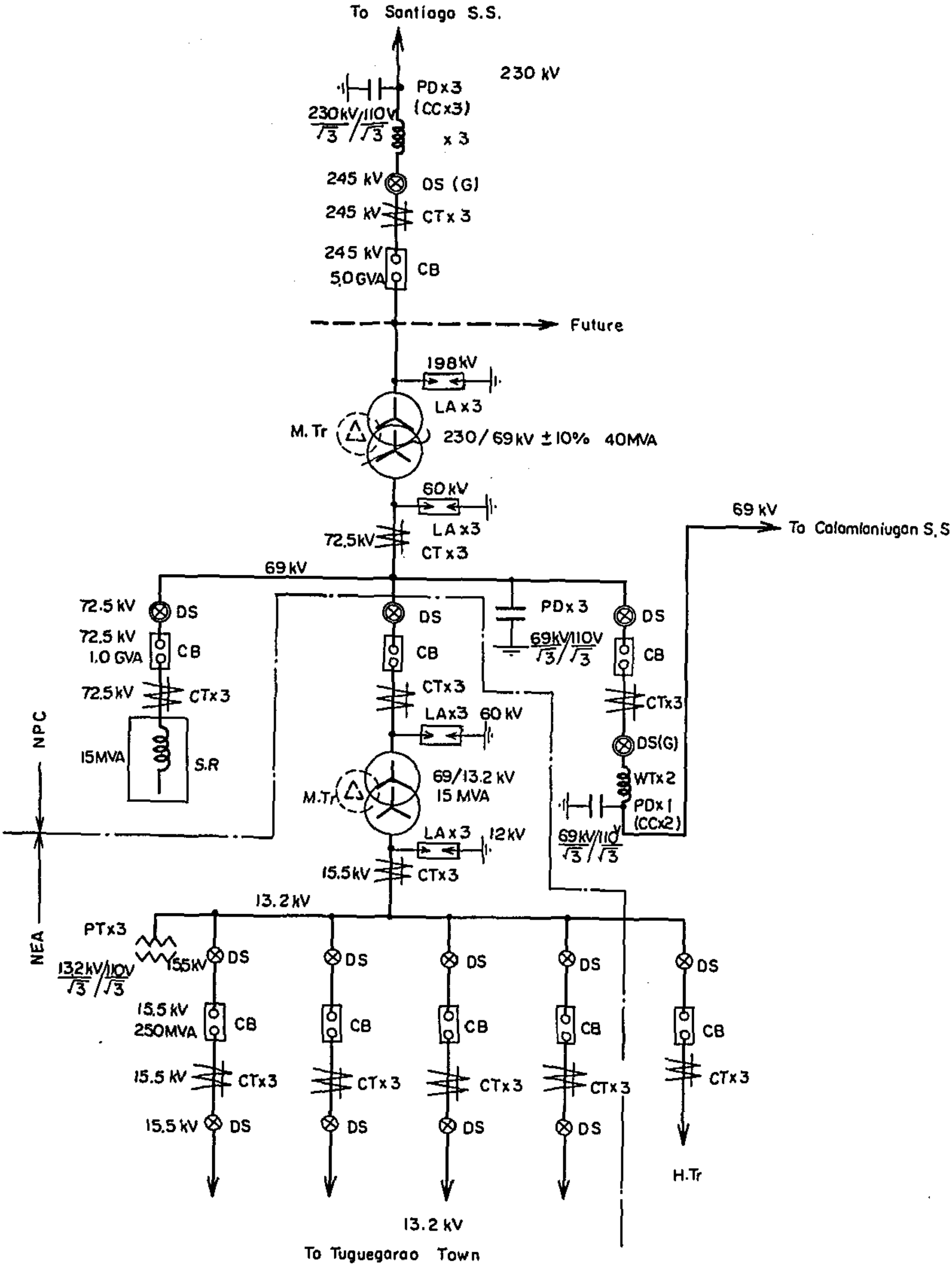


Fig.A-3-5 Skelton Diagram of Cauayan Substation.

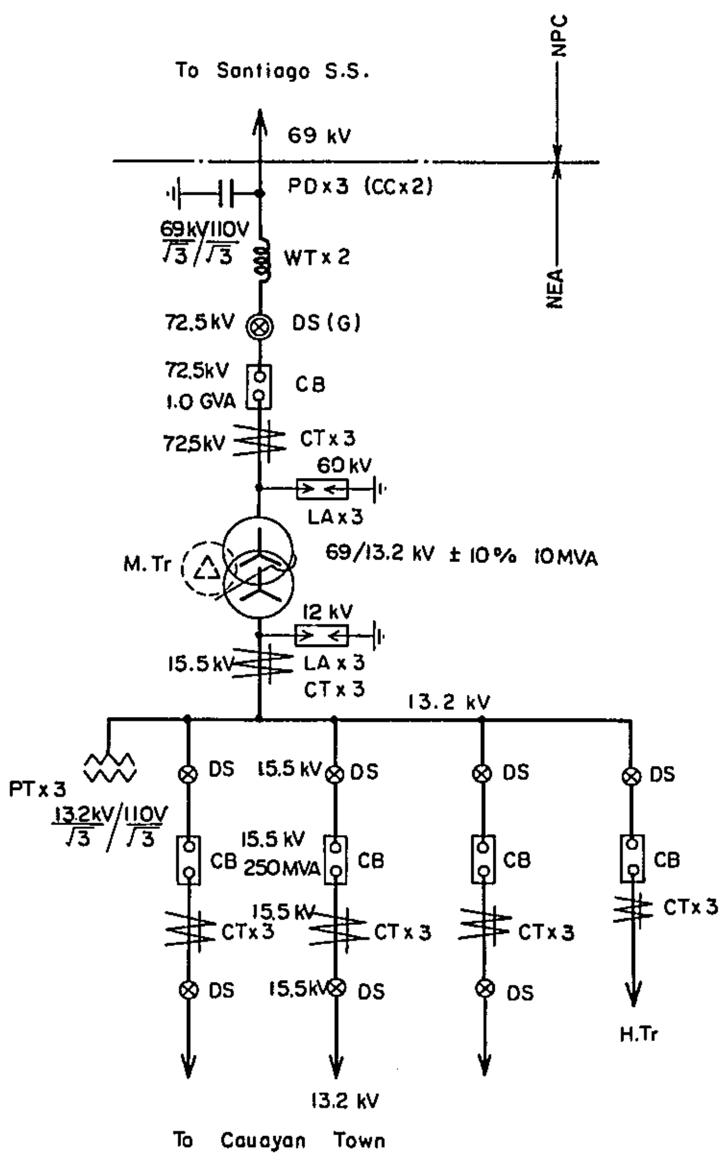


Fig.A-3-6 Skelton Diagram of Camalaniugan Substation or Ilagan Substation

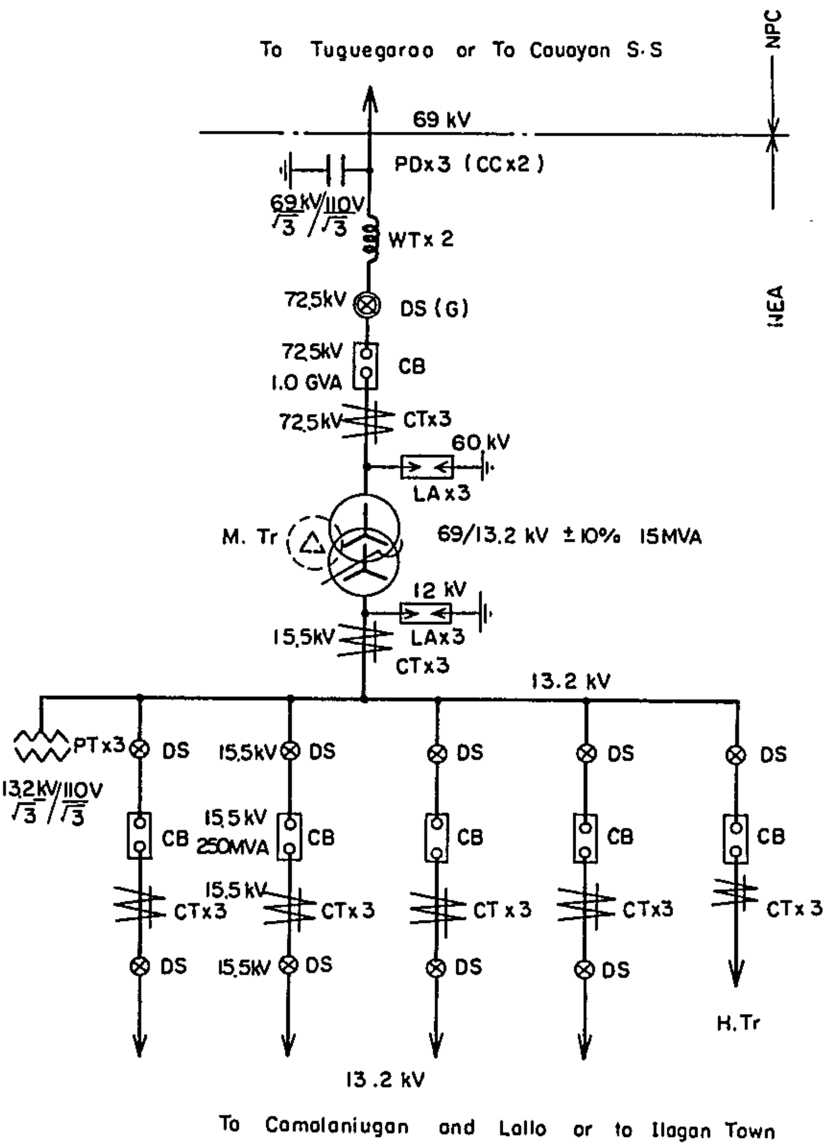
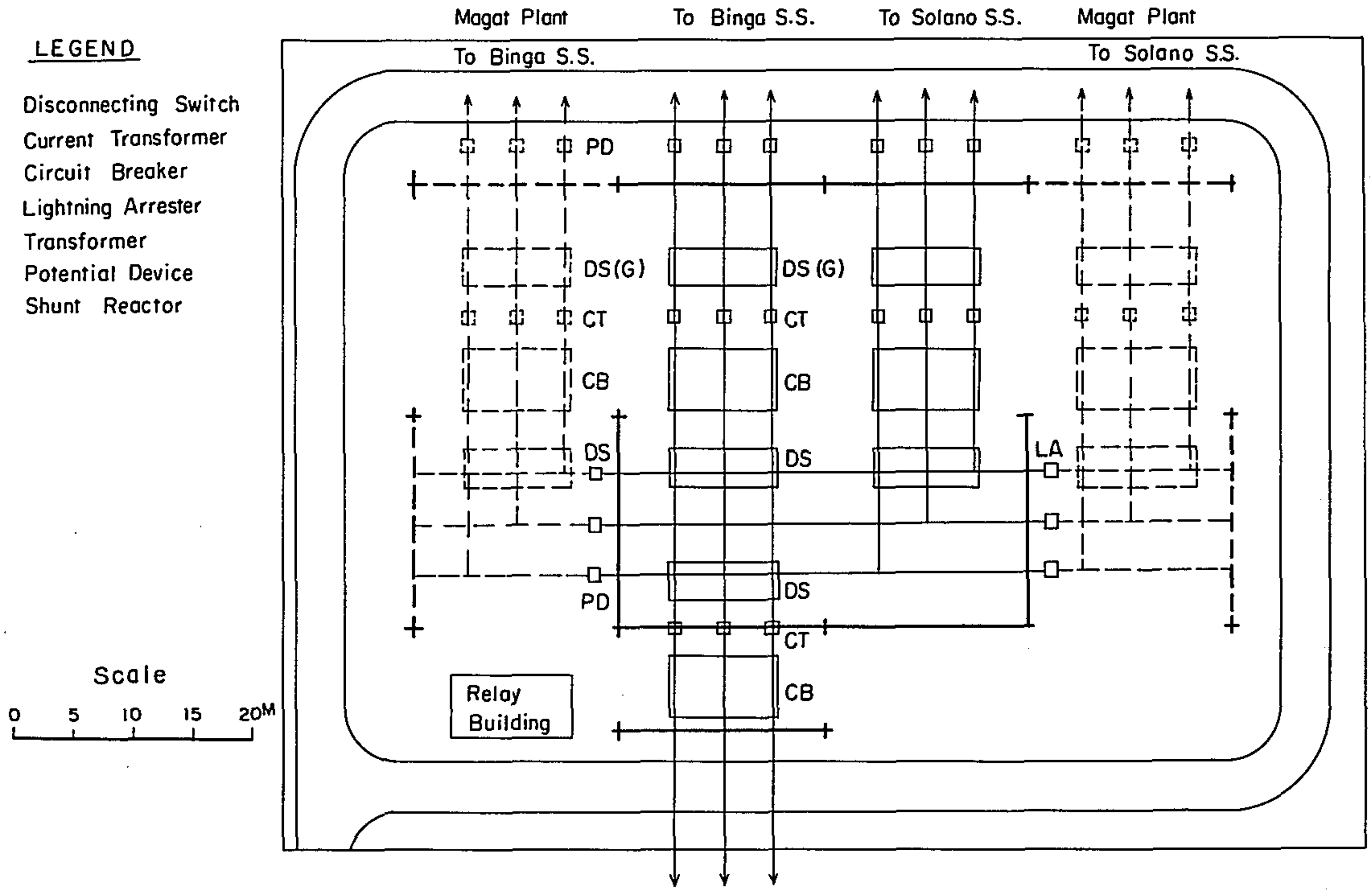


Fig.A-3-7 Layout of Ambuklao Switching Station

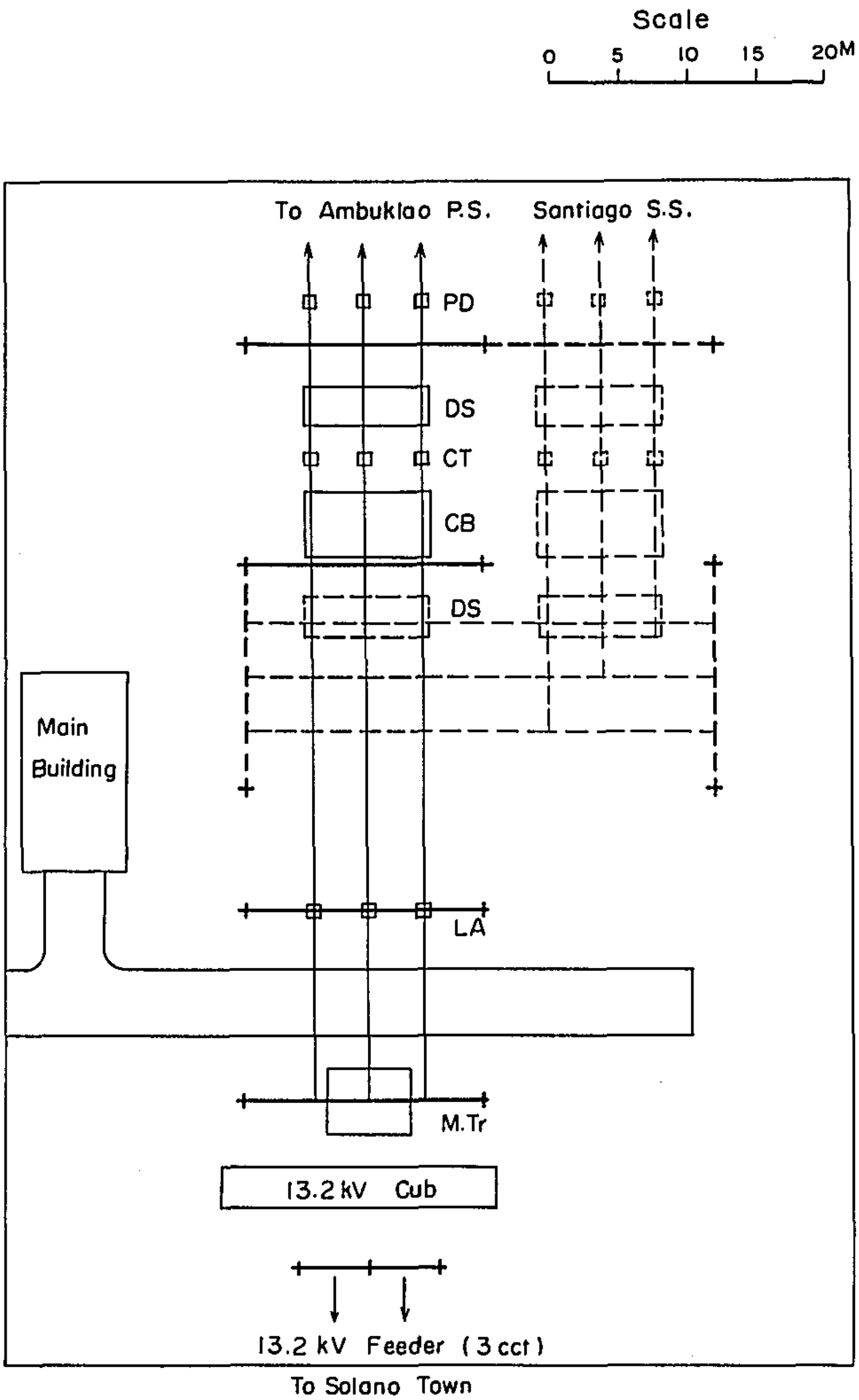
LEGEND

DS	Disconnecting Switch
CT	Current Transformer
CB	Circuit Breaker
LA	Lightning Arrester
Tr	Transformer
PD	Potential Device
SR	Shunt Reactor



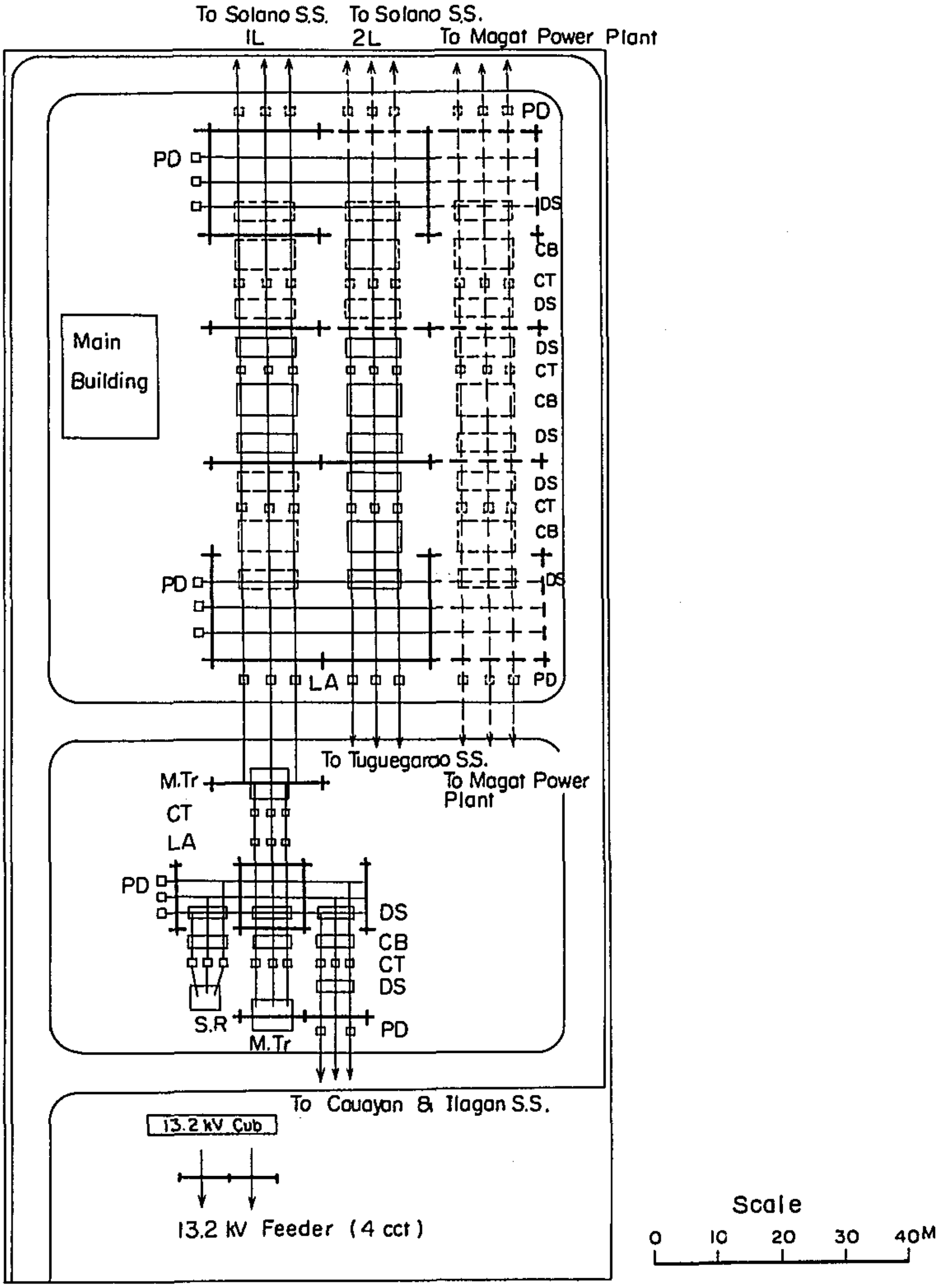
Area = 5,850 m^2

Fig.A-3-8 Layout of Solano Substation



Area = 5,580 m²

Fig.A-3-9 Layout of Santiago Substation.



Area = 19,000 m²

Fig.A-3-10 Layout of Tuguegarao Substation

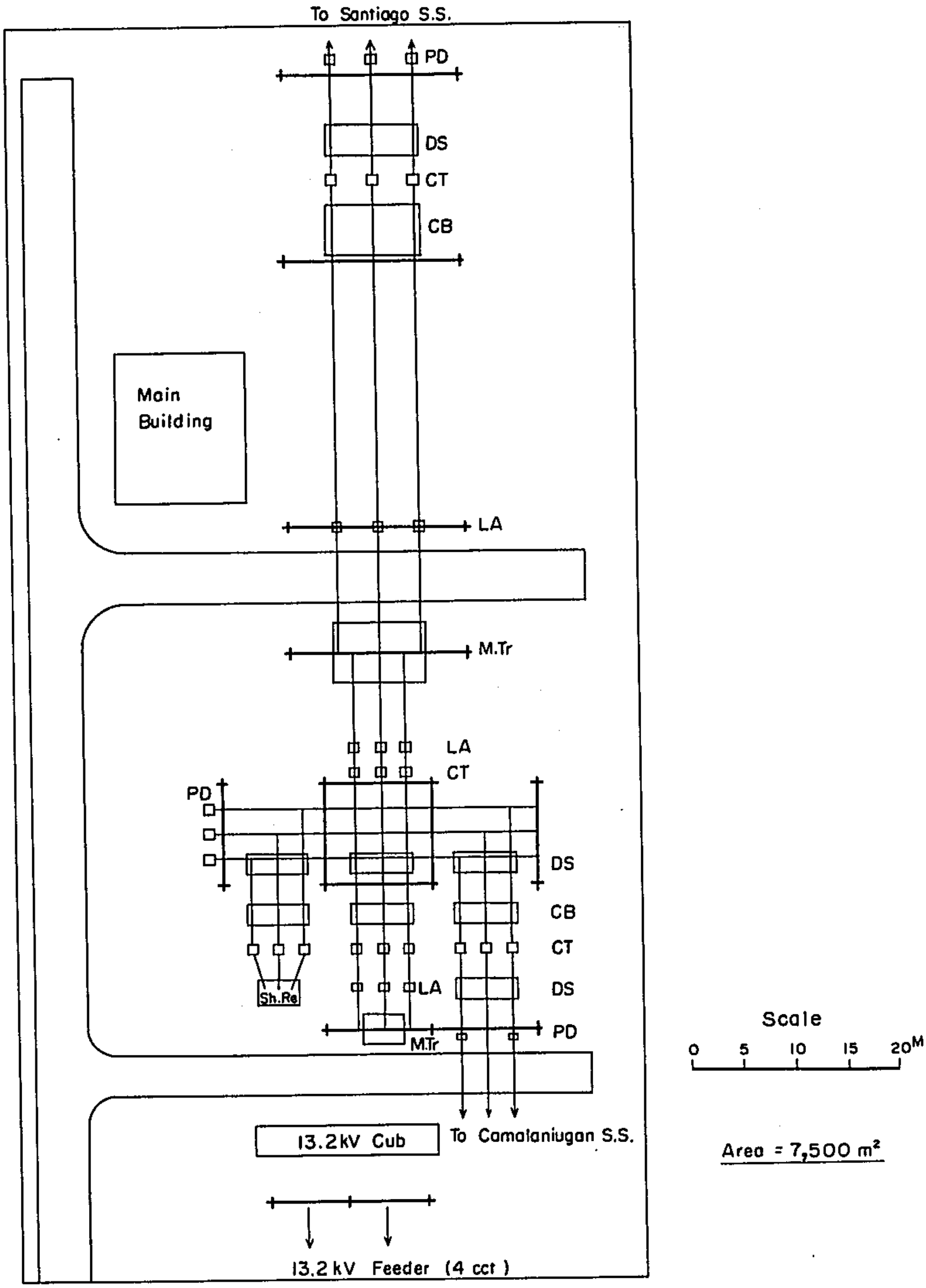


Fig.A-3-11 Layout of Ilagan, Cauayan and Camalaniugan Substation

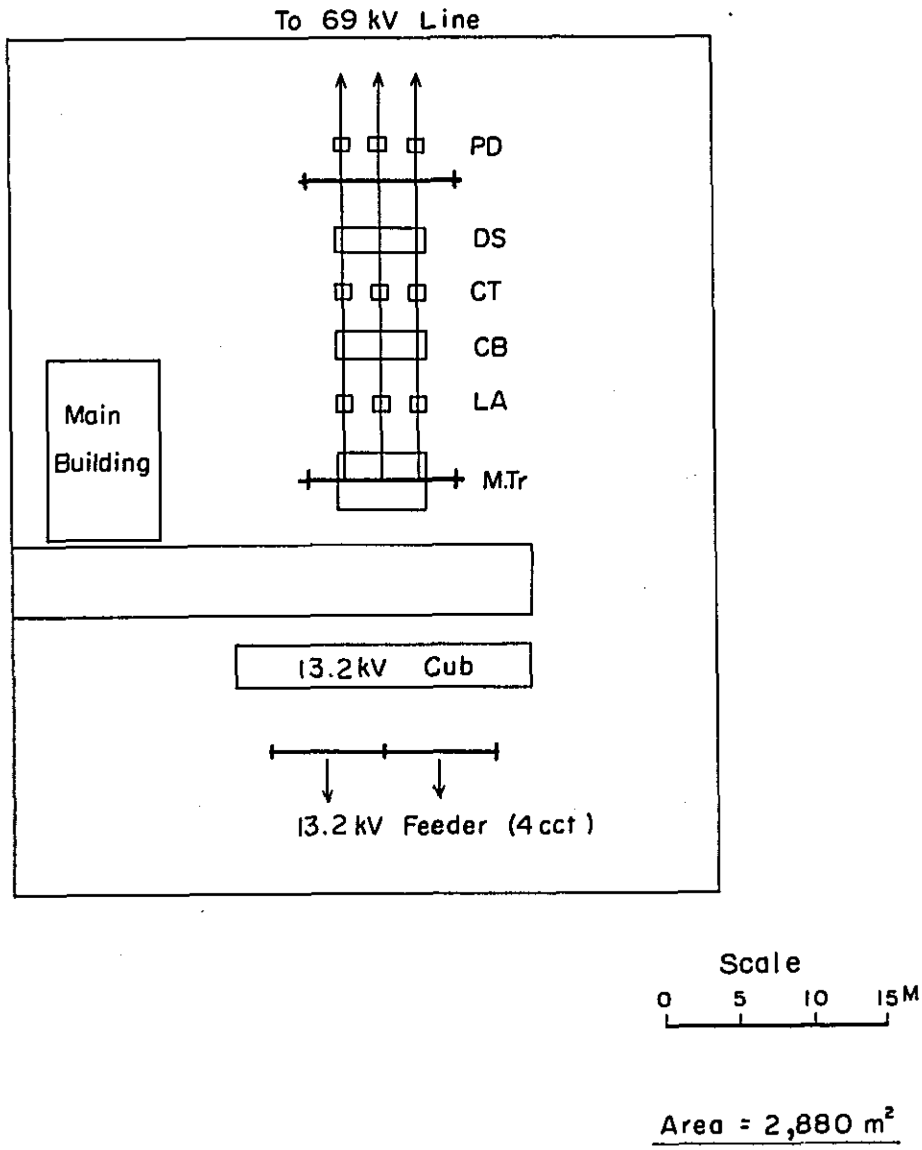


Fig.A-3-12 Tele-communication System Block Diagram (1)

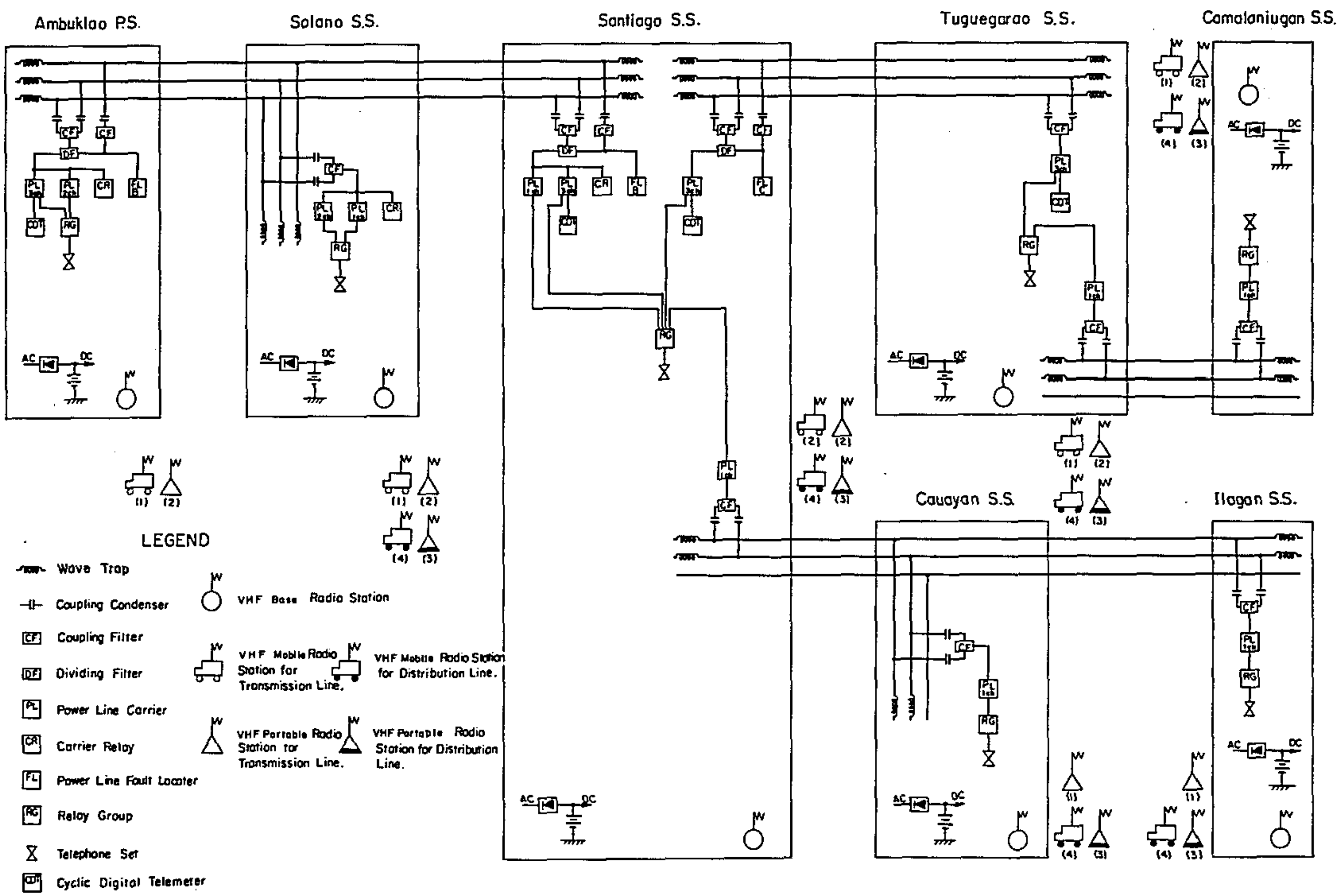


Fig.A-3-13 Tele - communication System Block Diagram (2)

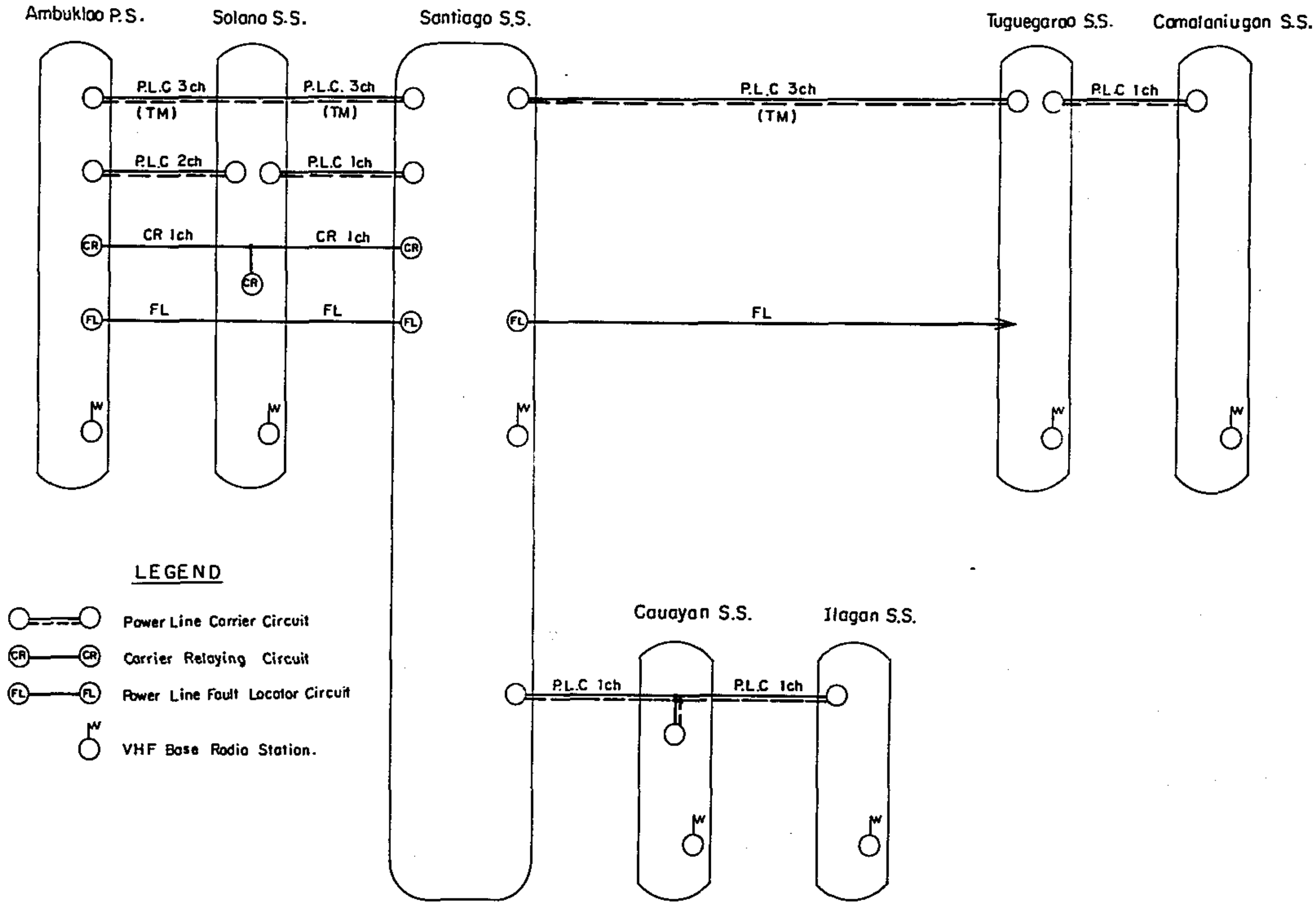
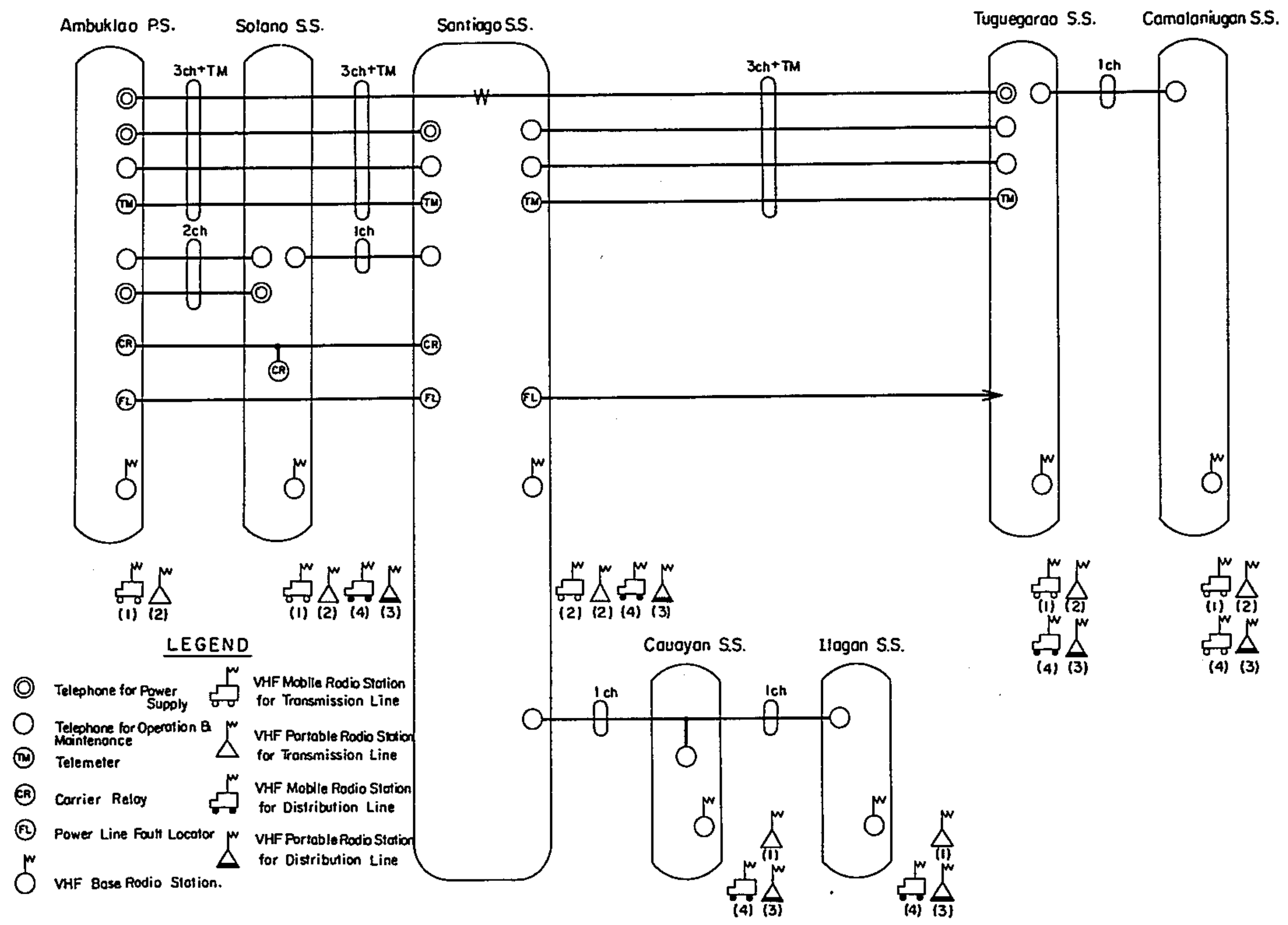


Fig.A-3-14 Channel Layout Diagram



APPENDIX A-4

ANALYSES OF ELECTRIC POWER SYSTEMS

A-4 Analyses of Electric Power Systems

A-4-1 Outline

Northern Luzon Power System is presently interconnected with the Central Luzon Power System up to Ambuklao Power Station approximately 150 km north of Manila, and in 1978 it is planned for the Cagayan Valley to become interconnected with the Luzon System by the 230 kV transmission lines (See Fig. A-4-1).

The objectives of this system analysis are to study a possibility of interconnection of the trunk transmission lines with the Central Luzon Power System from a technical standpoint with respect to voltage regulation, transient stability, short-circuit capacity, etc. Moreover, in conducting this analysis, careful attention was paid to future power development plans in the Cagayan Valley and its vicinities.

A-4-2 Voltage Regulation

(1) Voltage Regulation Criteria

Voltage regulation concerns how balance of reactive power of the system is to be taken and is performed through generators, voltage regulating equipment and transformer taps. In calculation of the voltage regulations, the Mexico bus voltage has been assumed to be 102% (234.6 kV) according to the IECO Report.

a. The ranges of voltage regulation were taken to be 100±5% for 230 kV system voltages, 105 to 90% for 69 kV system voltages, 105% for peak times and 95% (100±5% at 13.2 kV) for off-peak times for 13.2 kV system considering voltage drop of distribution systems, and 100±3% for generator terminal voltages (provided that this is within the range of generator power factor). It is necessary that at the time of interconnection due consideration be given to the tap voltage of transformers of Ambuklao Power Station.

b. Load power factors are to be 90% for peak times and 95% for off-peak times.

c. Regarding transformer taps, all except for the 69/13.2 kV transformers of Santiago and Tuguegarao Substations are to be with OLTC in view of the fact that voltage fluctuations on the load sides during peak and off-peak times are large.

d. The points of time for consideration are to be peak and off-peak time in 1978, 1982 and 1987 with system structure to be parts north of Mexico. The number of circuits, length of lines, capacity of transformers and their impedance are as shown in Impedance Map (See Fig. A-4-2).

e. The number of generators in parallel is to be full output during peak time and 1 unit in parallel as a rule during off-peak time.

(2) On-Load Tap Changer

Regarding tap range of OLTC, from the results of analyses of voltage regulation (See Table A-4-1), if the maximum range is about 15%, it would be possible to maintain target voltages on the 13.2 kV side at 105% for peak times and 95% for off-peak times, and if allowances for "on-load tap changer" are to be made, it would be adequate if a range of 20% is to be provided.

It should be noted that if OLTC is to be provided at the primary side, over-excitation of more than 5% may occur, depending on the tap location, and if this is to be allowed, it would be necessary to strengthen insulation of transformers.

If the taps are to be provided at secondary sides, the problem of over-excitation would disappear, and based on the fact that voltage fluctuation would be greater on the secondary sides than the primary sides, it was considered that OLTC would all be installed at secondary sides.

(3) Shunt Reactor

Since line currents are small during off-peak times and there is much reactive power produced from the lines, system voltage will be raised up to 110%. Transformers (taps 242 kV - 236.5 kV - 231 kV - 225.5 kV - 220 kV) of the existing Ambuklao Power Station will become over-excited. Accordingly, there is a necessity to bring the voltage of the 230 kV system to 105% or lower, and in order to achieve this, a total shunt reactor capacity of 30 MVA is required for the system. Therefore, it was planned for reactors of 15 MVA capacity each to be installed at the 69 kV sides of Santiago and Tuguegarao Substations.

(4) Shunt Capacitor

Through tap adjustment of OLTC it will be possible to maintain system voltage at the target value even in 1987 and shunt capacitors will be, therefore, unnecessary.

(5) Power Flow Diagram

The power flow diagrams for peak times and off-peak times in 1978, 1982 and 1987 are shown in Fig. A-4-3 through Fig. A-4-8.

A-4-3 Transient Stability

Transient stability calculations were made of single-circuit, 3 LG, 0 - CO for the cases tabulated below for peak times in 1982 and 1987, and the results indicated stability as shown by the swing curves in Fig. A-4-9 through Fig. A-4-13.

Year	Fault Location	Type of Fault	Breaker Acting time	Judgment
1982	Magat - Santiago	1 cct 3LG 0-CO	0.1S-0.5S-0.6S	Stable
"	Santiago - Ambuklao	"	0.1S-0.5S-0.6S	Unstable
"	Santiago - Ambuklao	"	0.1S-0.7S-0.8S	Stable
1987	Magat - Santiago	"	0.1S-0.5S-0.6S	Stable
"	Sadanga - Beckel	"	0.1S-05S-0.6S	Stable

However, if the reclosing time should be about 0.5 sec (30 Hz), a fault between Santiago and Ambuklao (length: 110 km) would cause a shock at a point of large swing to result in instability, but if the said time is made loger to around 0.8 sec (48Hz), the line will be stable. Consequently, it is thought advisable to provide reclosing apparatus with which it would be possible to adjust the reclosing time between 0.4 sec and 1.0 sec in three-phase reclosure and to set it for the time being at around 0.8 sec.

A-4-4 Short-Circuit Capacity

The short-circuit power distribution at peak time in 1987 is shown in Fig. A-4-14. The short-circuit capacity of the various stations are as indicated in Table A-4-2, and it will suffice for breaking capacities to be 5,000 MVA on the 230 kV sides, 1,000 MVA on the 69 kV side and 250 MVA on the 13.2 kV sides.

It is noted here that the generator constant was taken to be xd'.

Table A-4-1 Appropriate OLTC Tap Voltage (Max. Min.)

Substations		1978		1982		1987	
		Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
Salano	230/13.2 kV	104.0 (103.0)	91.0 (103.9)	106.0 (101.8)	90.5 (104.9)	106.0 (103.4)	91.0 (104.9)
Santiago	230/69 kV	101.5 (103.6)	94.0 (103.7)	105.0 (103.3)	94.0 (104.8)	107.0 (104.5)	93.5 (104.6)
"	69/13.2 kV	103.0 (103.6)	103.0 (92.5)	102.0 (105.0)	102.0 (93.3)	103.5 (105.0)	103.5 (92.2)
Cauayan	66/13.2 kV	101.0 (101.2)	98.5 (92.2)	102.5 (100.1)	97.5 (92.5)	105.5 (98.1)	100.0 (90.9)
Ilagan	66/13.2 kV	102.0 (100.1)	98.5 (92.0)	102.5 (98.3)	97.5 (92.1)	108.5 (95.1)	100.5 (90.3)
Tuguegarao	230/69 kV	100.0 (104.3)	94.0 (103.1)	104.0 (103.4)	94.5 (104.1)	106.5 (103.4)	93.5 (103.9)
"	69/13.2 kV	103.0 (103.4)	103.0 (92.1)	102.0 (105.0)	102.0 (93.4)	103.5 (105.0)	103.5 (92.2)
Camalaniugan	66/13.2 kV	100.0 (101.8)	98.5 (92.0)	101.0 (101.2)	98.5 (92.7)	107.5 (96.7)	98.5 (91.5)
Claveria	66/13.2 kV	-	-	-	-	106.5 (95.5)	99.5 (91.8)

Note:
1. Figures in parenthesis indicate primary side voltage in %.
2. All OLTC taps are to be installed at secondary sides.
3. Voltages employ the percent values corresponding to 230 kV, 69 kV and 13.2 kV.
4. Target voltages on 13.2 kV side are to be 105% during peak times and 95% during off-peak times, respectively.
5. 66 kV taps are to be used at receiving substations.
6. For 69/13.2 kV transformers at Santiago and Tuguegarao, no-load tap changers have been employed.

Table A-4-2 Short-Circuit Capacity

(Peak Time in 1987)

Station		Breaking Capacity (MVA)	Remarks
Ambuklao	230 kV	2,828	xd' is used as generator constant.
"	69 kV	246	
"	13.2 kV	709	
Solano	230 kV	1,521	
"	13.2 kV	107	
Santiago	230 kV	1,630	
"	69 kV	201	
"	13.2 kV	100	
Tuguegarao	230 kV	549	
"	69 kV	160	
"	13.2 kV	89	
Magat	230 kV	1,591	
"	Generator Terminal	1,581	
Cauayan	69 kV	110	
"	13.2 kV	60	
Ilagan	69 kV	81	
"	13.2 kV	51	
Camalaniugan	69 kV	72	
"	13.2 kV	53	
Claveria	69.kV	41	
"	13.2 kV	35	

Fig. A-4-1 Power System Diagram for Northern Luzon in 1987

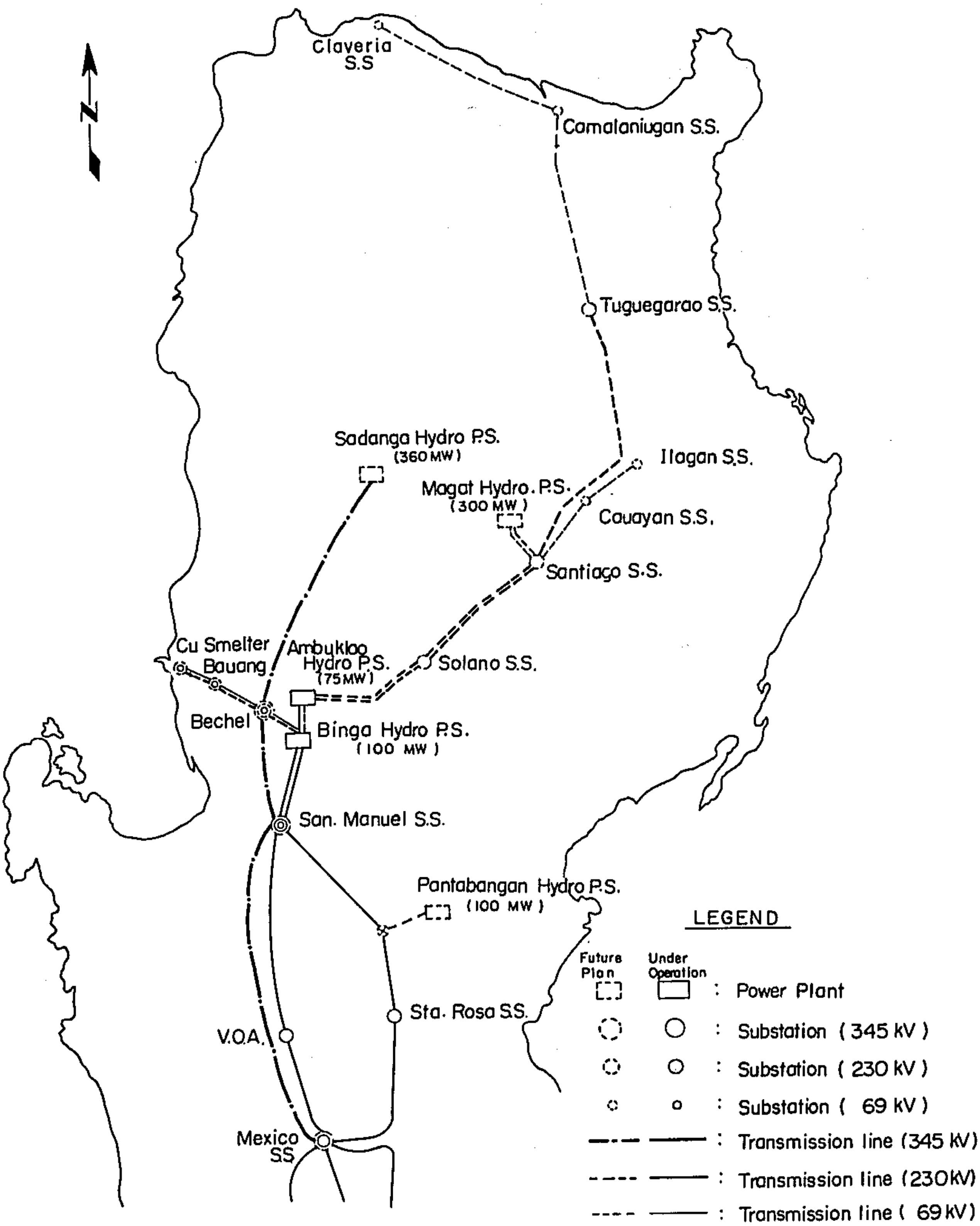


Fig. A-4-2 Northern Luzon Power System in 1987

Impedance Map, 100MVA, 345kV, 230kV Base.

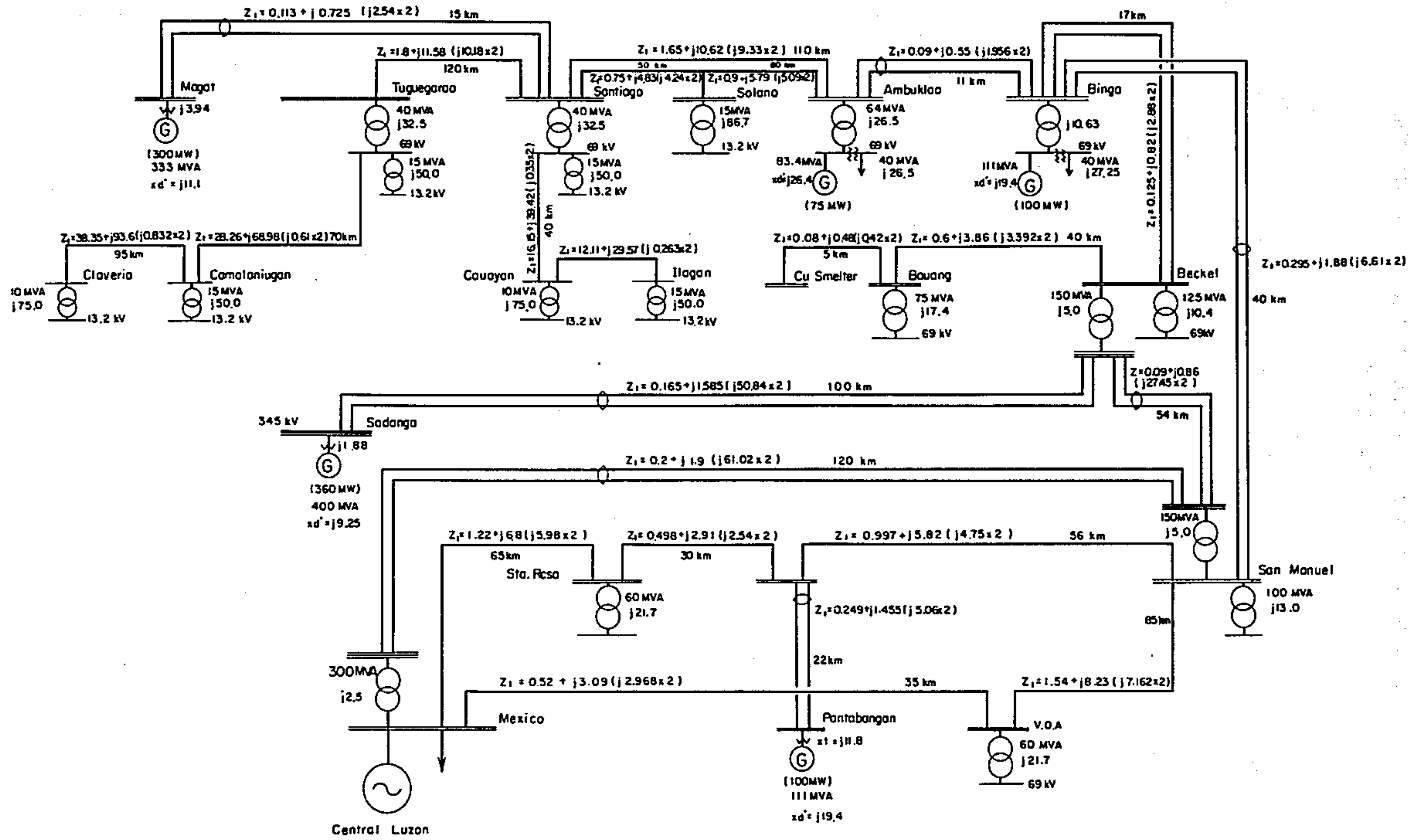


Fig. A-4-3 Northern Luzon Power System in 1978
Voltage Regulation at Peak Time

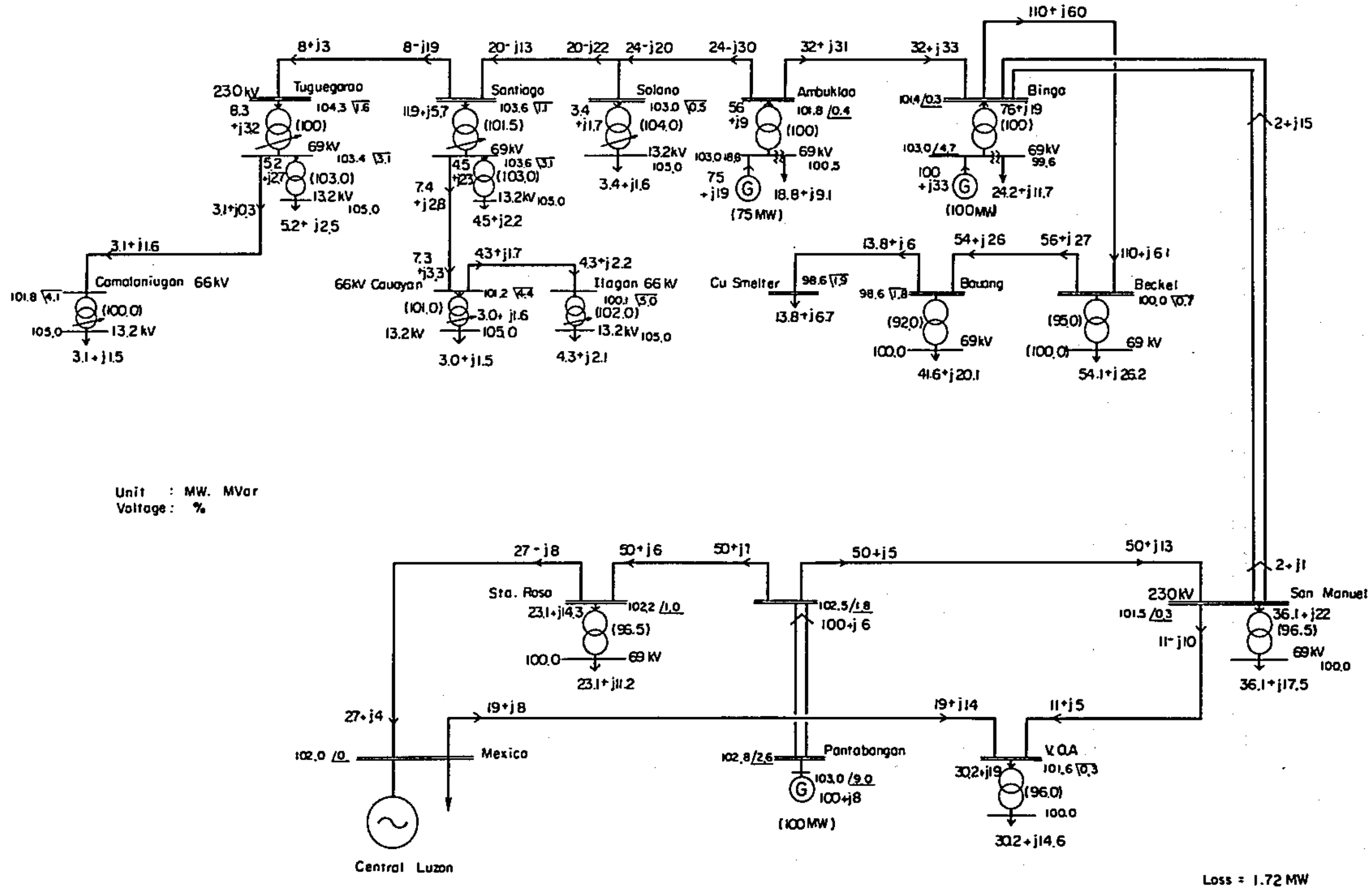


Fig. A-4-4 Northern Luzon Power System in 1978 Voltage Regulation at Off Peak Time.

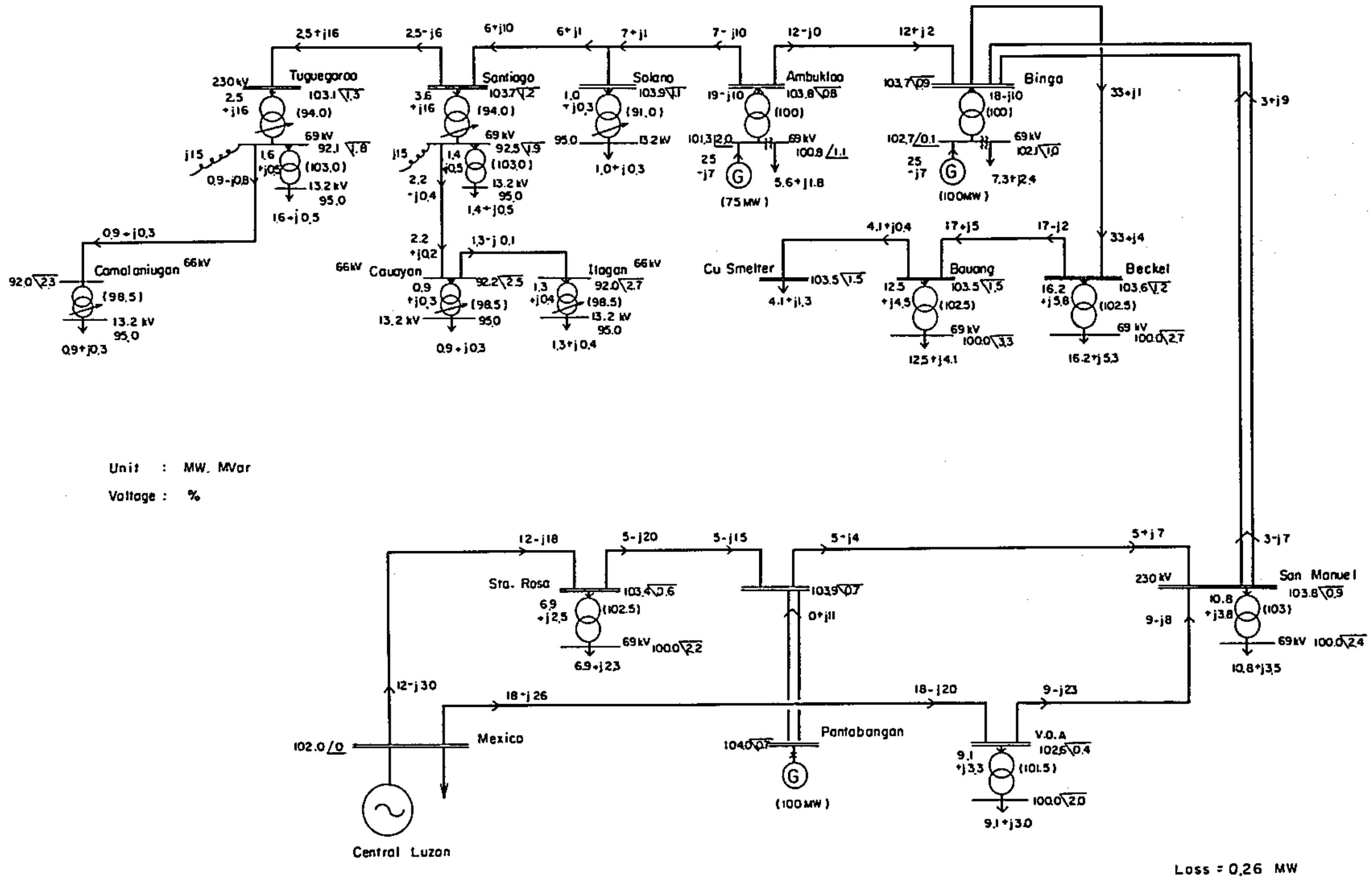


Fig. A-4-5 Northern Luzon Power System in 1982

Voltage Regulation at Peak Time.

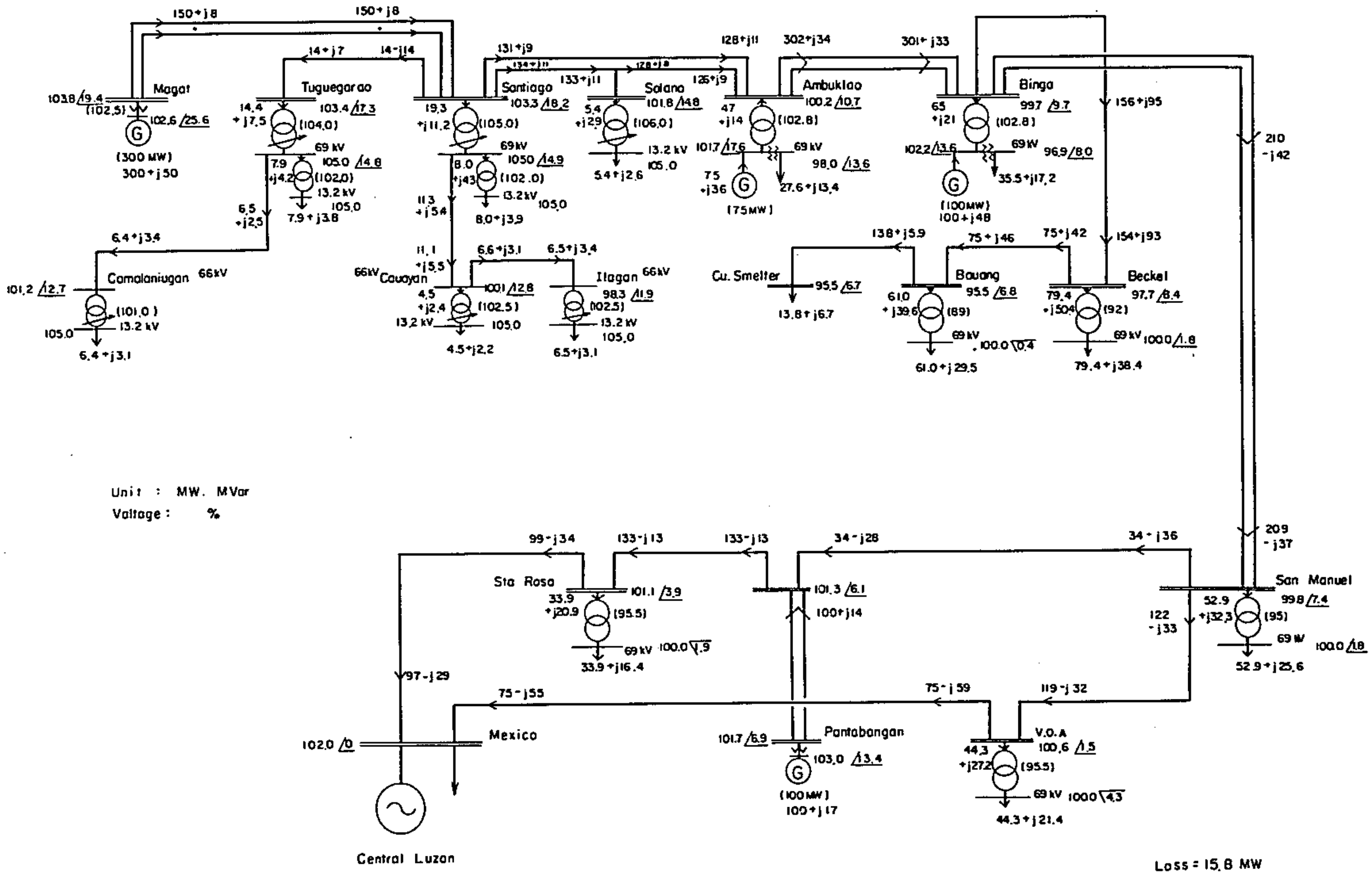


Fig. A-4-6 Northern Luzon Power System in 1982 Voltage Regulation at Off Peak Time.

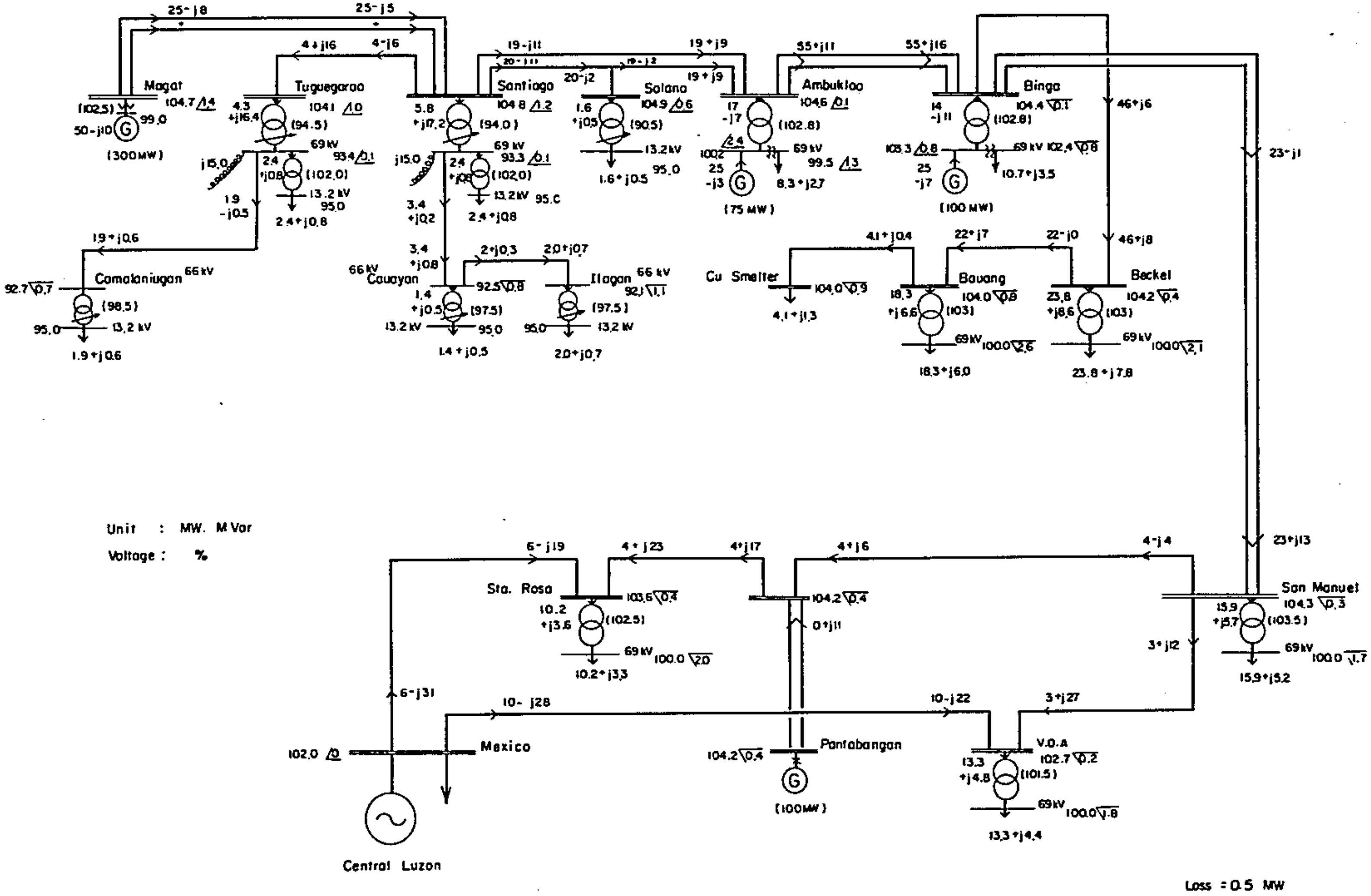


Fig. A-4-7 Northern Luzon Power System in 1987
Voltage Regulation at Peak Time.

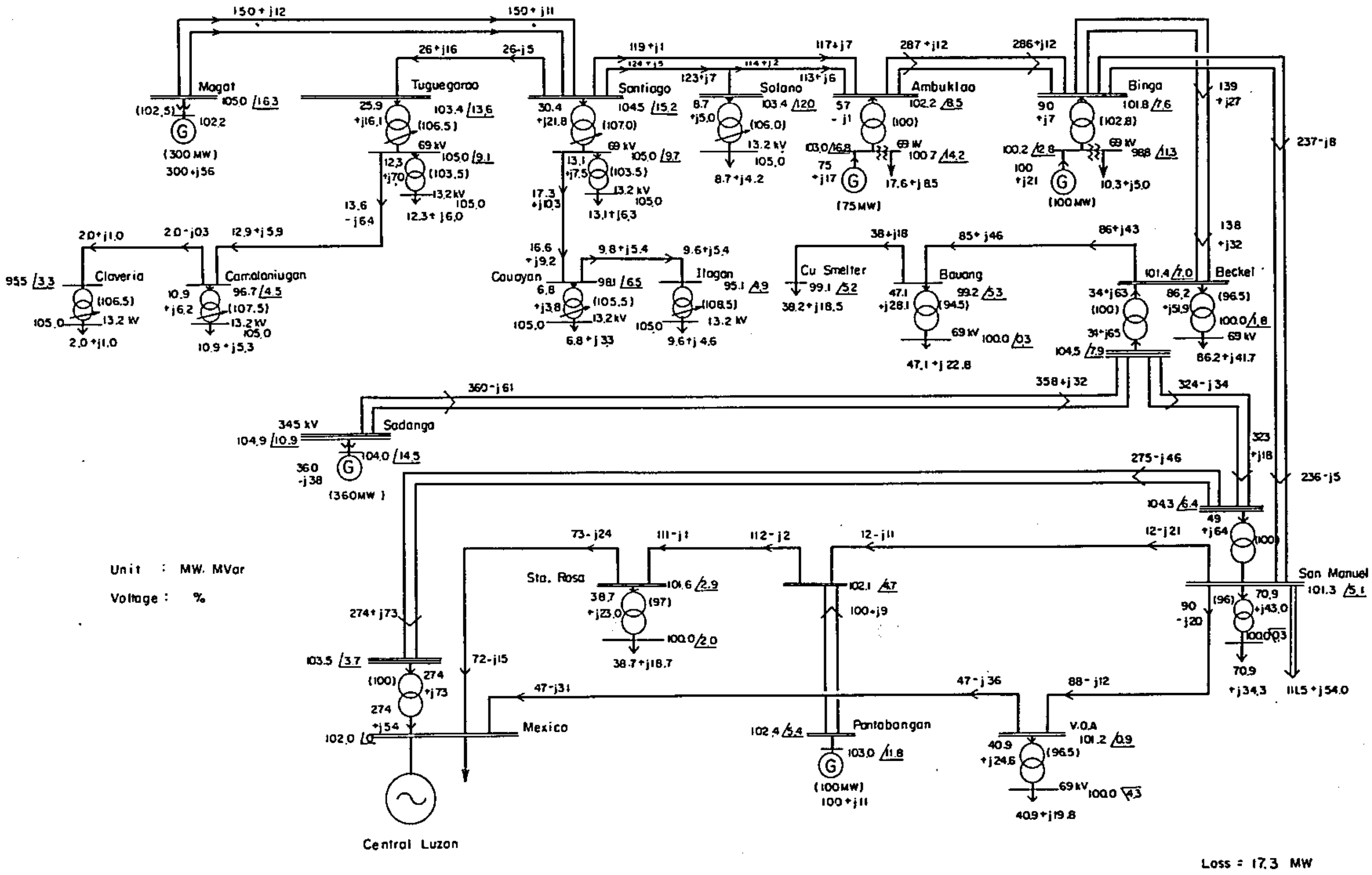


Fig. A-4-8 Northern Luzon Power System in 1987 Voltage Regulation at Off Peak Time.

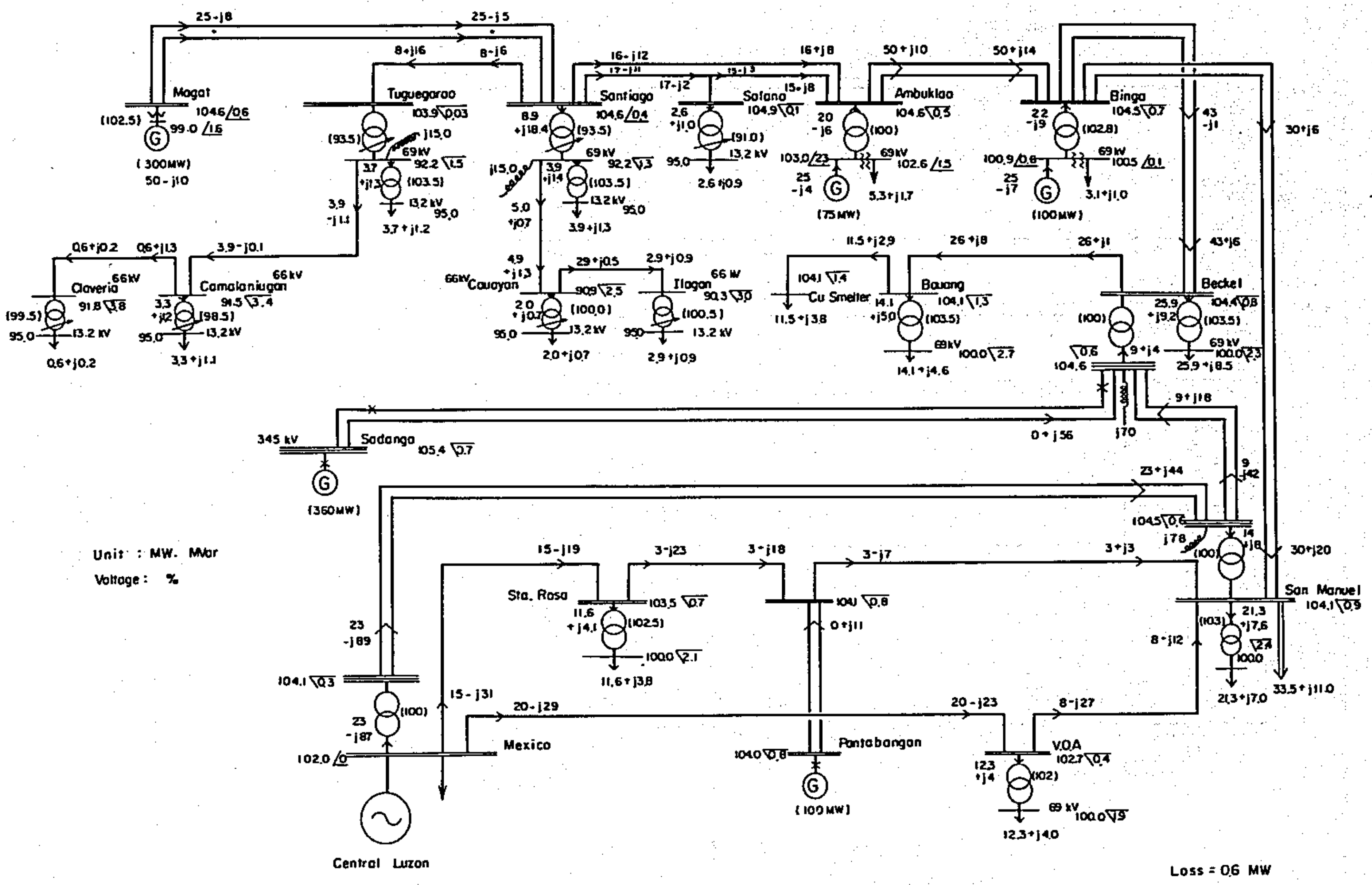


Fig.A-4-9 Transient Stability Analysis (1)

1982P *MAGAT-SANTIAGO 1CCT 3LG 0-CO

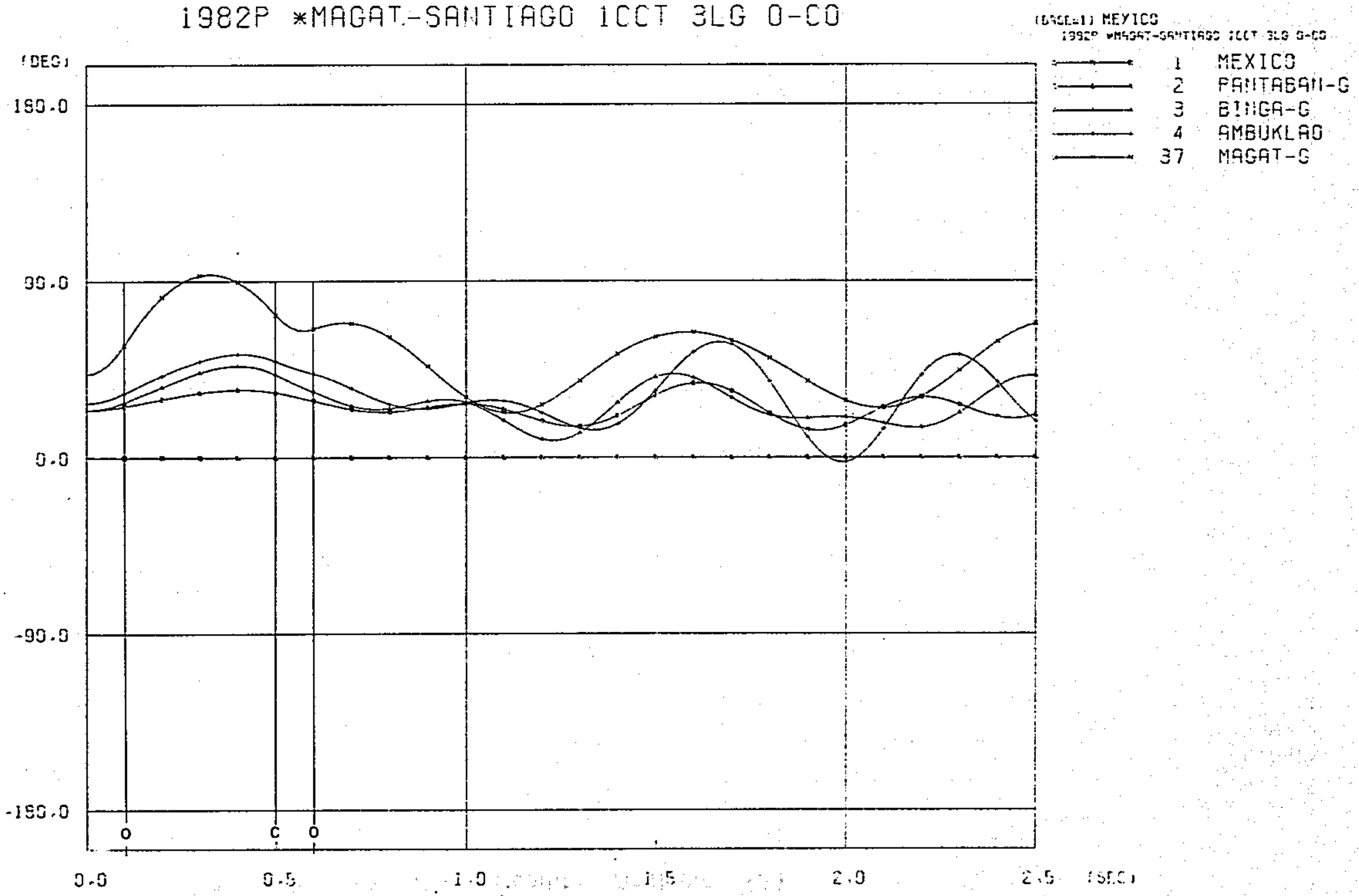


Fig. A-4-10 Transient Stability Analysis (2)

1982P ×SANTIAGO AMBUK 1CCT 3LG 0 CO

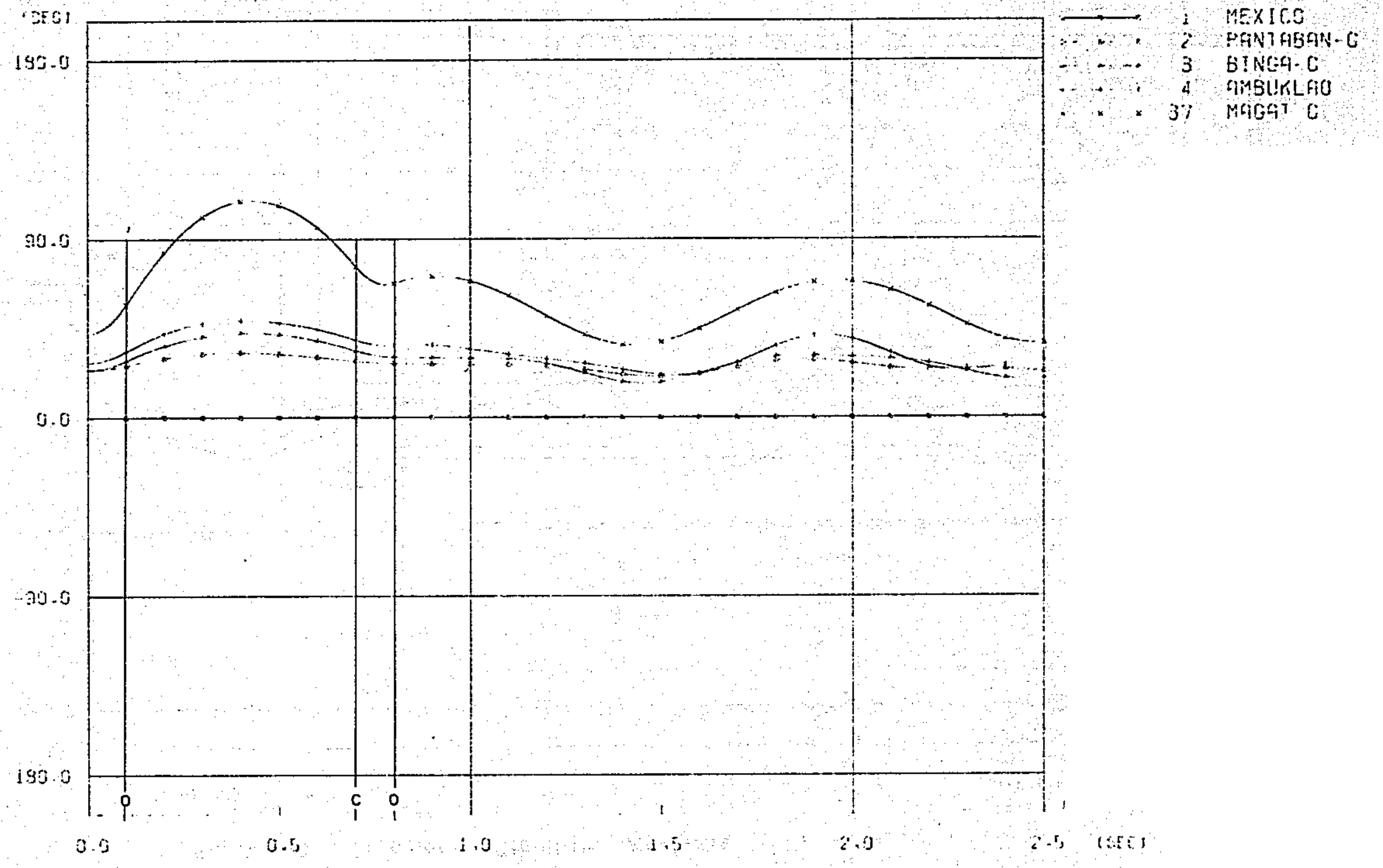


Fig. A-4-11 Transient Stability Analysis (3)

1982P *SANTIAGO-AMBUK 1CCT 3LG 0-CO

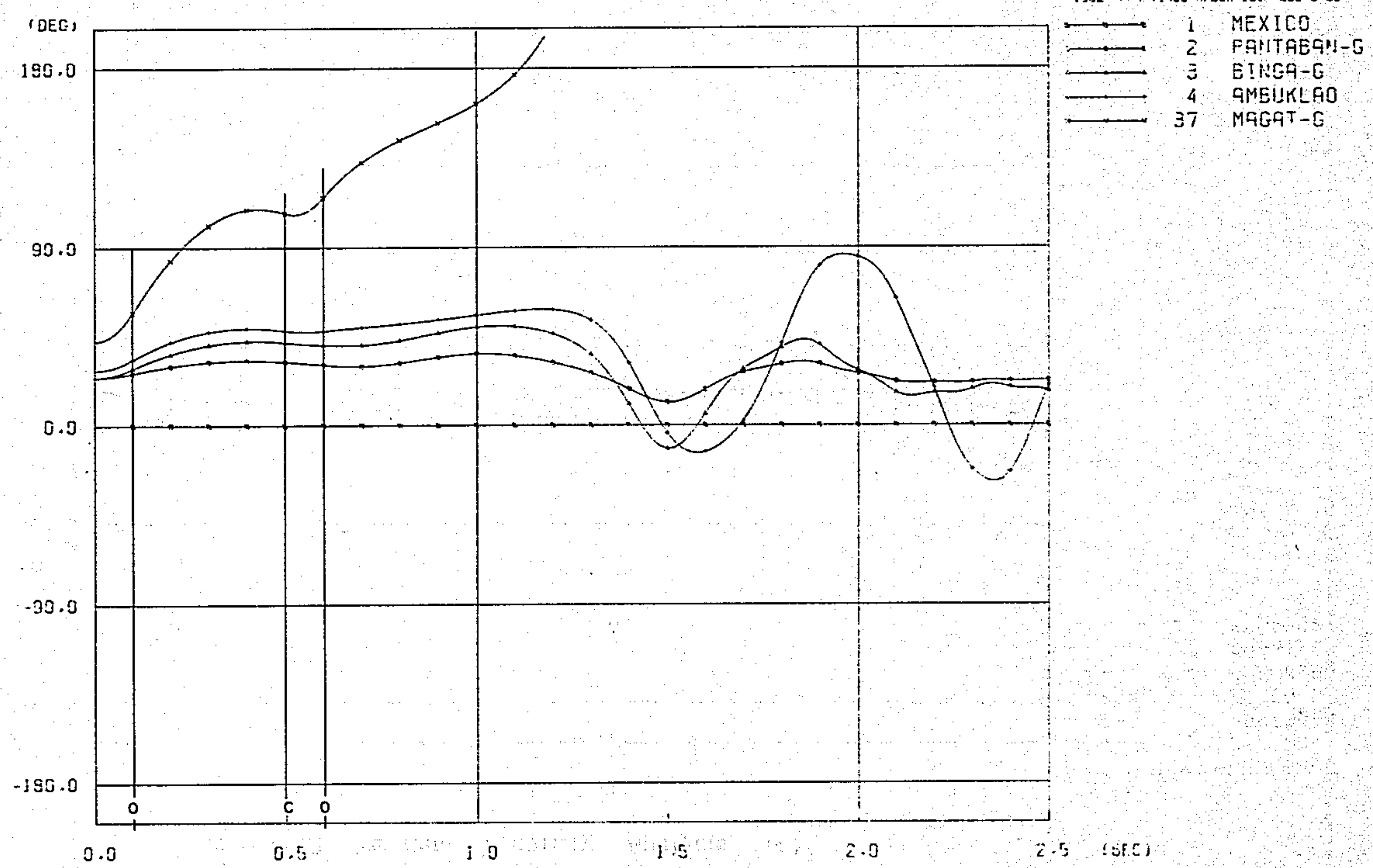


Fig. A-4-12 Transient Stability Analysis (4)

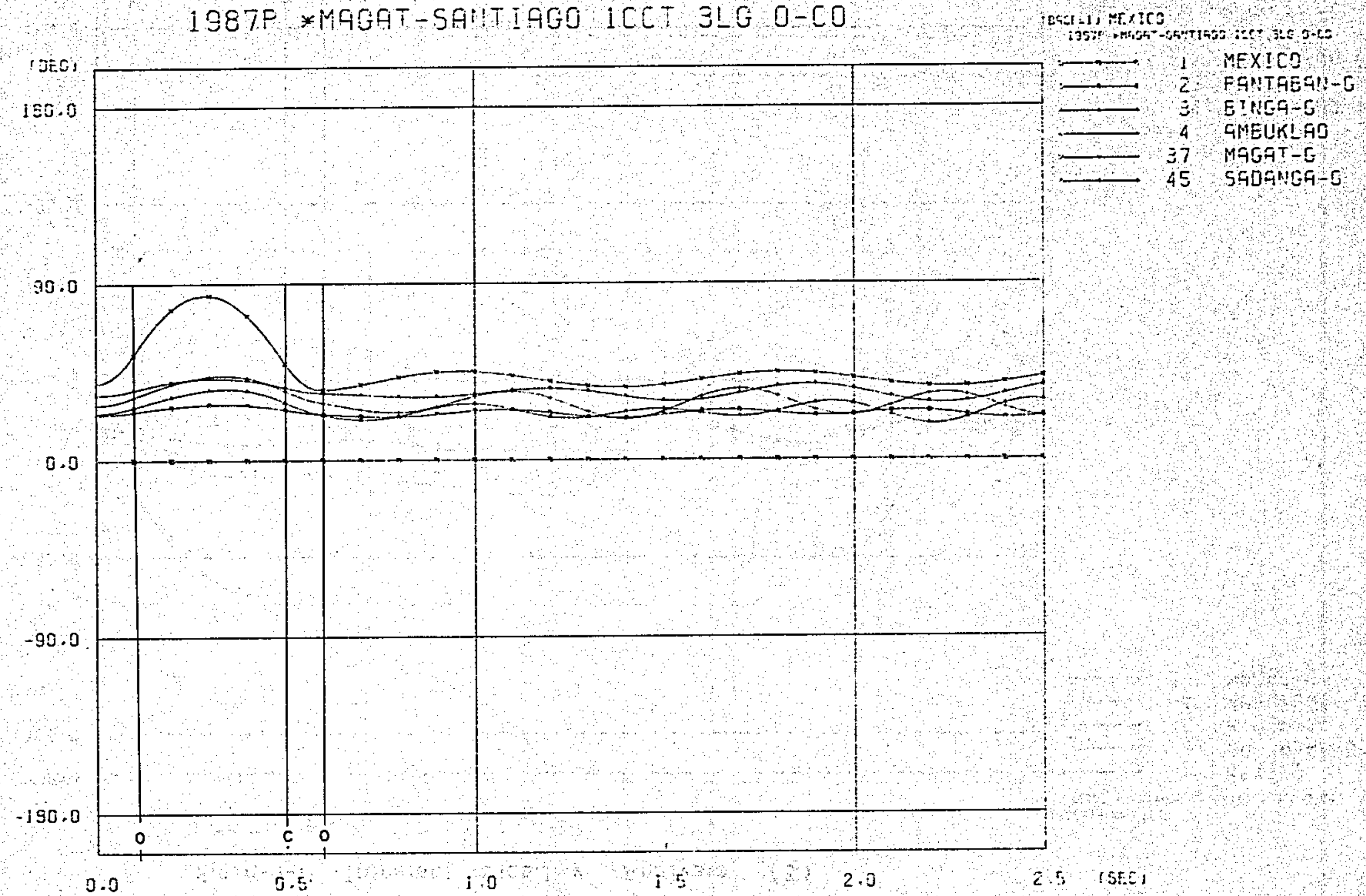


Fig. A-4-13 Transient Stability Analysis (5)

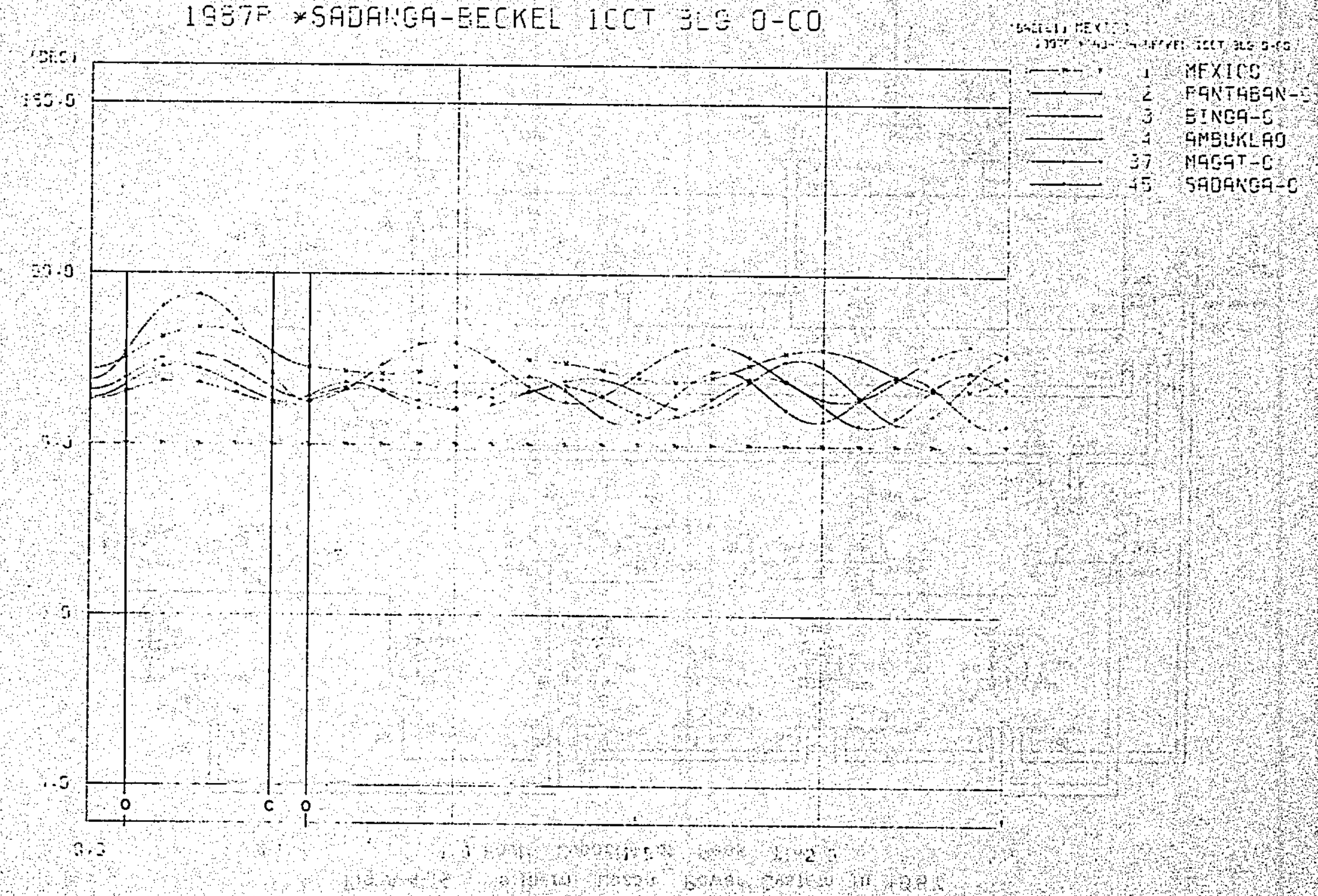
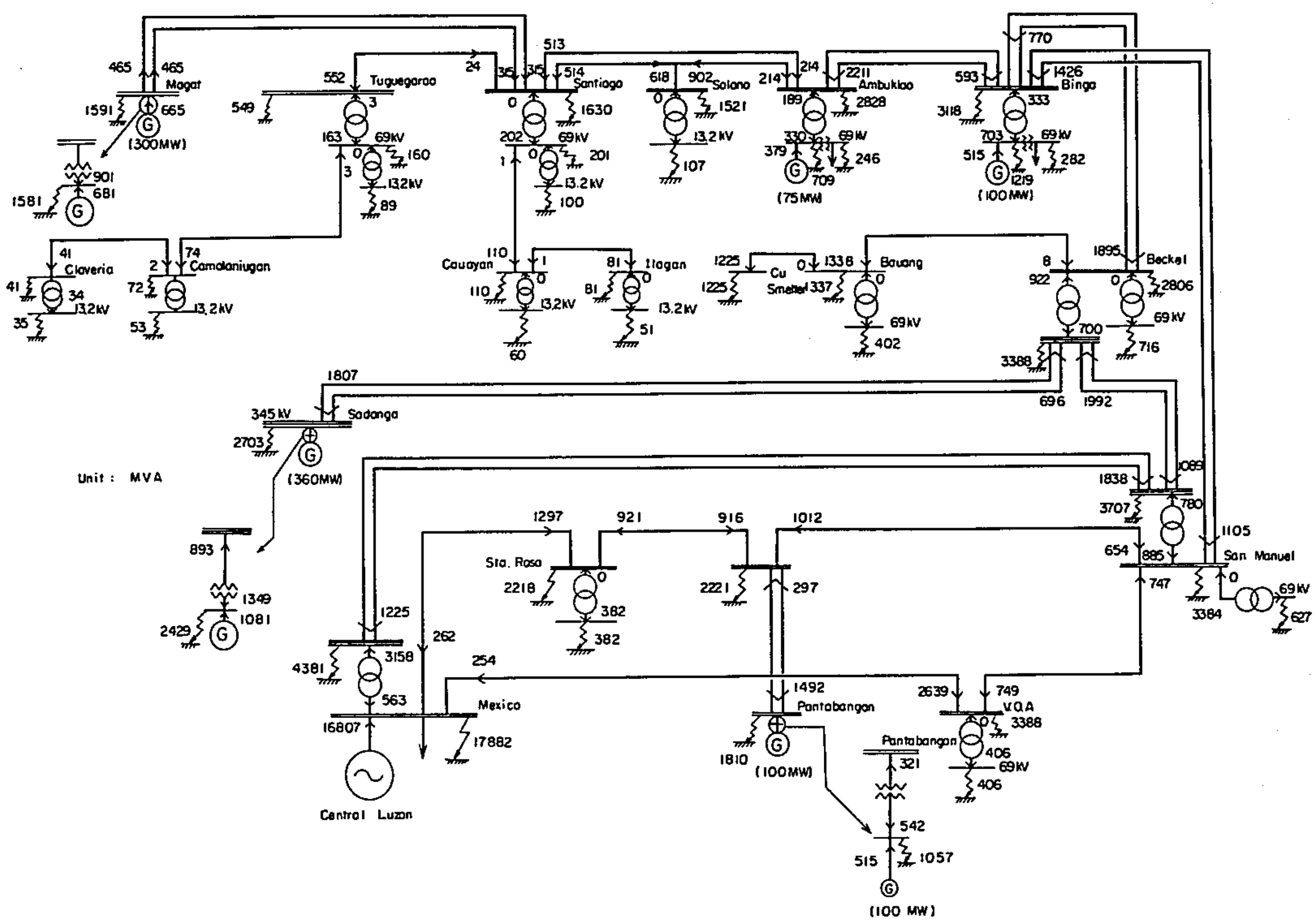


Fig. A-4-14 Northern Luzon Power System in 1987
Fault Capacity at Peak Time.



APPENDIX A-5

PROTECTIVE RELAY SYSTEM OF TRANSMISSION LINES

A-5 Protective Relay System of Transmission Lines

A-5-1 Basic Principle of Preliminary Design

The protective relay system of the transmission lines including the reclosing system has been designed in consideration of the conditions and forms of transmission systems, such as conditions of system interconnection, neutral grounding systems, etc. as well as frequency of lightning tripouts and future plans in the Valley.

(1) Santiago to Solano to Ambuklao (230 kV, 1cct)

Initially, this will be a single-circuit transmission line with a power source only at the Ambuklao end, but in the future (1982) with putting into service equipment of Magat Power Station at Santiago, it will become a double-circuit transmission line. Consequently, this will be an important interconnecting transmission line, and regarding the protective relaying system and reclosing system, design work has been carried out in anticipation of stringing another circuit in the future.

(2) Santiago to Tuguegarao (230 kV, 1 cct)

Until interconnection of the Chico Hydro Power Complex with Tuguegarao Substation, the Santiago end will be a power source and Tuguegarao will be a receiving substation. Therefore, in the way of a protective relaying system, there is to be a distance relaying system at the Santiago end and a combination of an overcurrent relaying system and an undervoltage relaying system at the Tuguegarao end. Further, at the Santiago end, a low-speed reclosing system is to be provided in order to facilitate quick fault clearance. After realization of interconnection of the Chico Hydro Power Complex with Tuguegarao, the line will become an interconnecting transmission line and the protective relaying system is to be replaced by a power line carrier relaying system.

(3) Ilagan to Cauayan to Santiago (69 kV, 1 cct)

The Santiago end will be the power source with Ilagan and Cauayan being receiving substations. Therefore, the protective relaying system is to consist of a distance relaying system at the Santiago end. At each receiving end, combination of an overcurrent relaying system and an undervoltage relaying system should be equipped. Further, in order to facilitate quick fault clearance, a low-speed reclosing system is to be provided at Santiago.

(4) Camalaniugan to Tuguegarao (69 kV, 1 cct)

The Tuguegarao end will be the power source with Camalaniugan being the receiving substation. Therefore, the protective relaying system is to consist of a distance relaying system at the Tuguegarao end. As for the Camalaniugan end, a combination of an overcurrent relaying system and an undervoltage relaying system is to be equipped. Further, in order to facilitate quick fault clearance, a low-speed reclosing system is to be provided at Tuguegarao.

A-5-2 Outline of Preliminary Design

(1) Santiago to Solano to Ambuklao (230 kV, 1 cct)

Santiago and Ambuklao

Protective Relaying System

Main Protection: Distance directional comparison systems combined with power line carrier relaying system

Back-up Protection: Distance relaying system

Reclosing System

Three-phase low-speed reclosing (only Ambuklao)

Single-phase and three-phase high-speed reclosing

Solano

Protective Relaying System

Main Protection: Distance directional comparison system combined with line carrier relaying system

Back-up Protection: Overcurrent and undervoltage relaying systems

(2) Santiago to Tuguegarao (230 kV, 1 cct)

Santiago

Protective Relaying System

Distance relaying system

Reclosing System

Three-phase low-speed reclosing

Tuguegarao

Protective Relaying System

Overcurrent and undervoltage relaying systems

(3) Santiago to Cauayan to Ilagan (69 kV, 1 cct)

Santiago

Protective Relaying System

Distance relaying system

Reclosing System

Three-phase low-speed reclosing

Cauayan and Ilagan

Protective Relaying System

Overcurrent and undervoltage relaying systems

(4) Camalaniugan to Tuguegarao (69 kV, 1 cct)

Tuguegarao

Protective Relaying System

Distance relaying system

Reclosing System

Three-phase low-speed reclosing

Camalaniugan

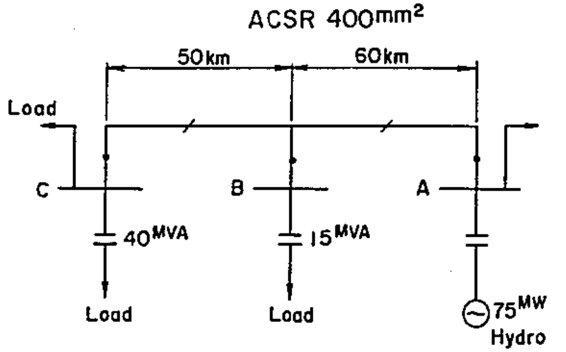
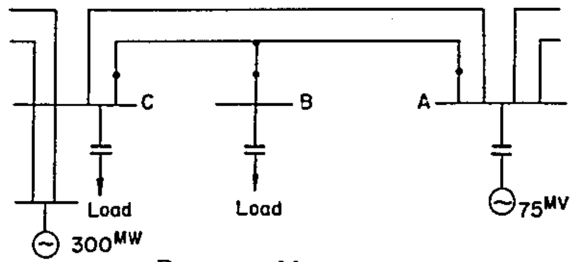
Protective Relaying System

Overcurrent and undervoltage relaying Systems

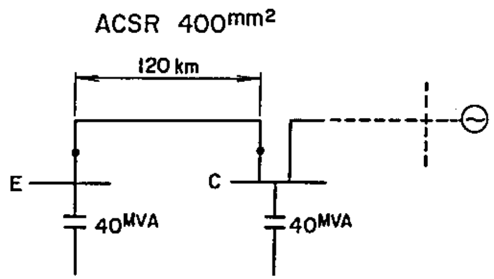
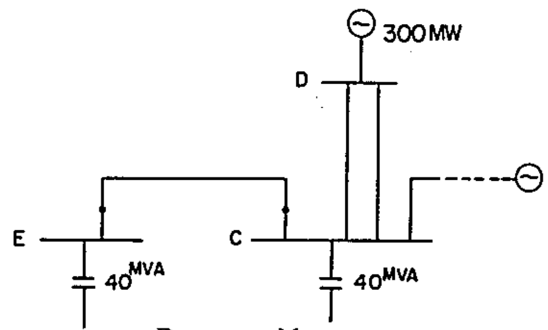
A-5-3 Outline of Facilities

See Data 1 - 3.

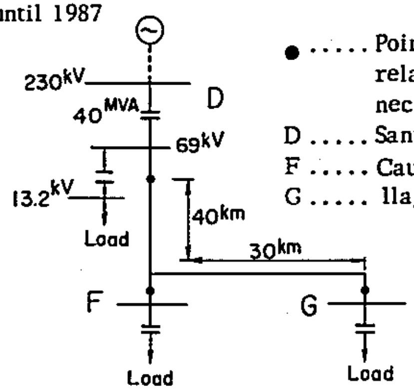
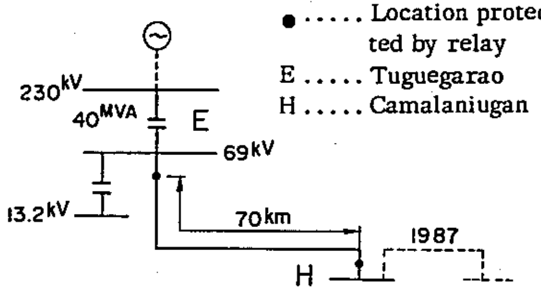
(Data 1)

Section to be protected	Voltage & Neutral Grounding System	System Description	Signal Transmission System	Protective Relaying System
Santiago —— Solano —— Ambuklao	230kV, Direct Grounding System	in 1978  ● .... Points where the relays are connected A .... Ambuklao B .... Solano C .... Santiago from 1982  D .... Magat	Power Line Carrier System Ordinary Time Carrier Sending System	Main Protection (1 series) Distance directional Comparison System Terminal A .....Only power source Terminal B .....Only load Terminal C .....Variable both for power source and load Backup Protection (1 series) Distance relaying System (Terminals A, C) Overcurrent and Undervoltage relaying System (Terminal B) Reclosing System High-speed reclosing, 1ϕ, 3ϕ Applicable to terminals A, C 3ϕ to be used from 1982 Low-speed reclosing, 3ϕ Only Terminal A Relays Used ...Electromagnetic Number of Panels Terminal A, C 3 panels Terminal B 1 panel

(Data 2)

Section to be protected	Voltage & Neutral Grounding System	System Description	Protective Relaying System
Santiago — Tuguegarao	230kV, Direct Grounding System	in 1978  ● .... Points where the relays are connected C .... Santiago E .... Tuguegarao from 1982  D .... Magat	Main Protection (1 series) Terminal C ..... Distance Relaying System Terminal E ..... Overcurrent and Undervoltage Relaying Systems note) Changeover to power line carrier relay system planning for 1987 Reclosing System Low-speed Reclosing, 3ϕ Only Terminal C Relays Used ..... Electromagnetic Number of Panels Terminal C 2 Panels Terminal E 1 Panel

(Data 3)

Section to be protected	Voltage & Neutral Grounding System	System Description	Protective Relaying System
Ilagan —— Cauayan —— Santiago	Direct Grounding System	until 1987  ● ..... Points where the relays are connected D ..... Santiago F ..... Cauayan G ..... Ilagan	Main Protection Terminal D ..... Distance Relaying System Terminal F ..... Overcurrent and Undervoltage Relaying System Terminal G ..... Overcurrent and Undervoltage Relaying System Reclosing System Low-speed Reclosing, 3ϕ Only Terminal D Relays Used ..... Electromagnetic Number of Panels Terminal D 2 Panels Terminal E, G 1 Panel
Camalaniugan —— Tuguegarao	Direct Grounding System	until 1982  ● ..... Location protected by relay E ..... Tuguegarao H ..... Camalaniugan	Main Protection Terminal E ..... Distance Relaying System Terminal H ..... Overcurrent and Undervoltage Relaying Systems Reclosing System Low-speed Reclosing, 3ϕ Only Terminal E Relays Used ..... Electromagetic Number of Panels Terminal E 2 Panels Terminal H 1 Panel

APPENDIX A-6

DISTRIBUTION LINE SCHEME

Fig.A-6-1 Distribution System - 7.62/13.2 kV, 3 Phase, 4 Wire, Common Neutral Multiple Grounding System.

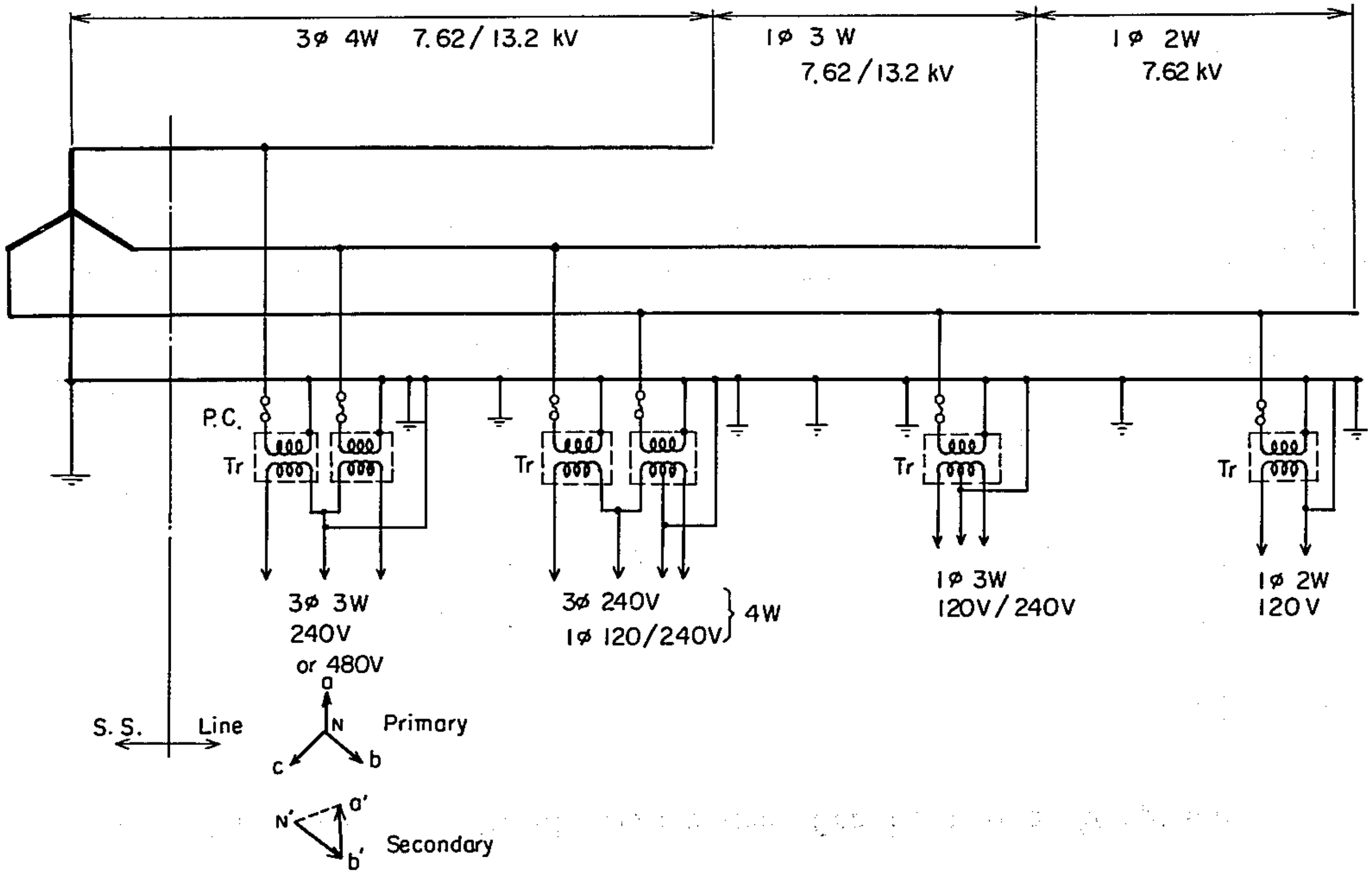


Fig.A-6-2 Layout of Model Distribution Facilities and Equipment.

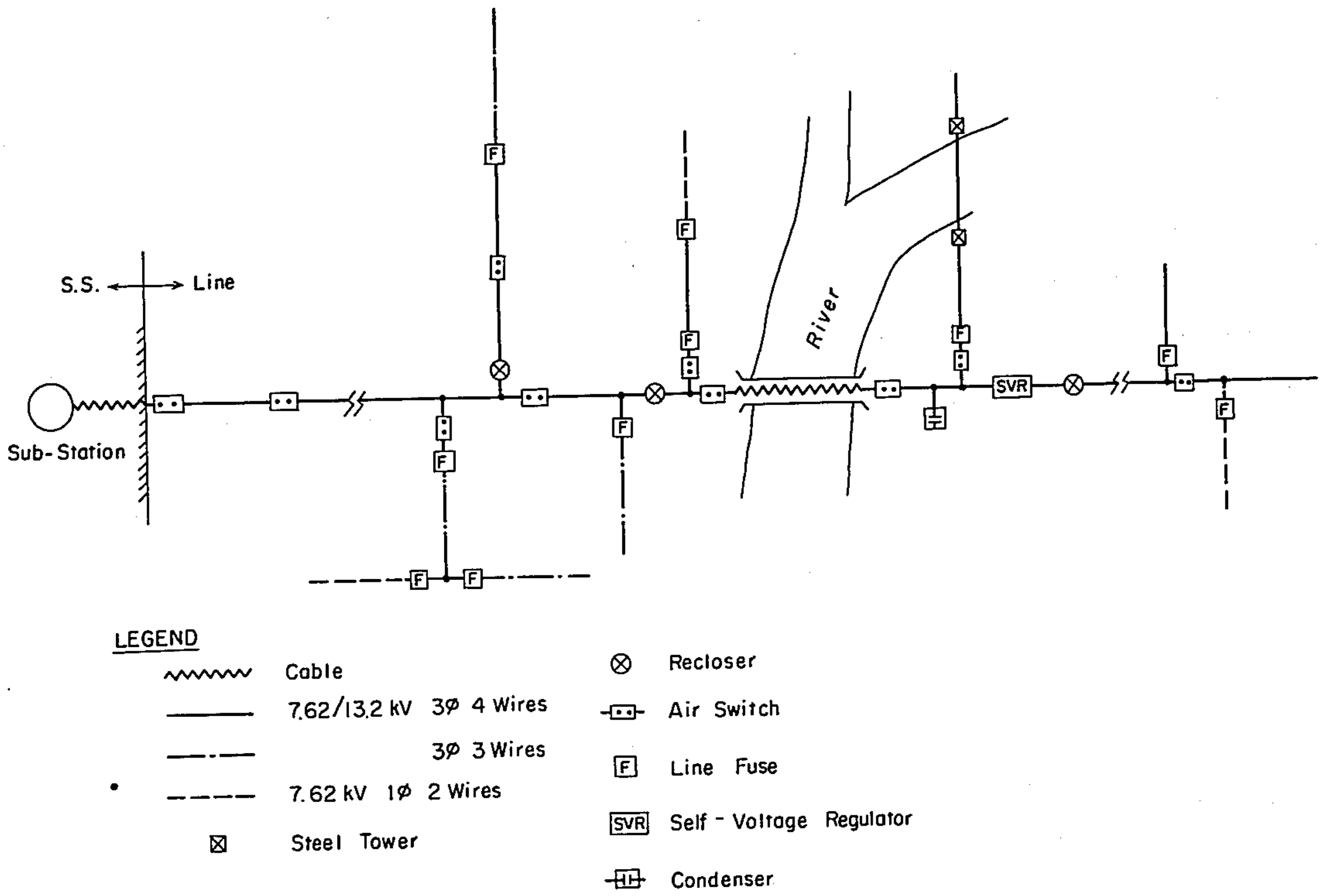
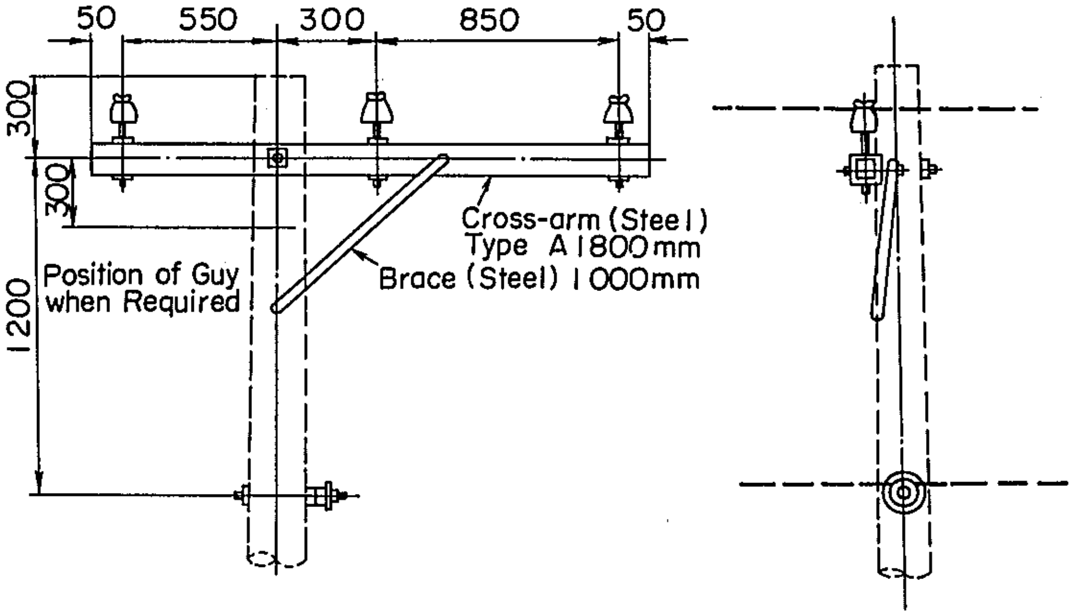
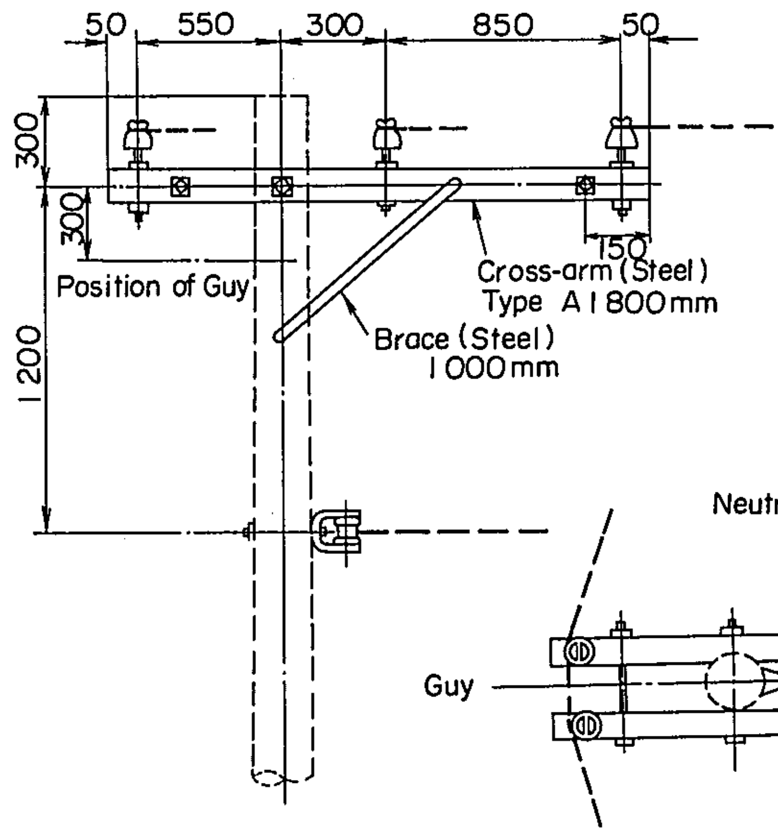


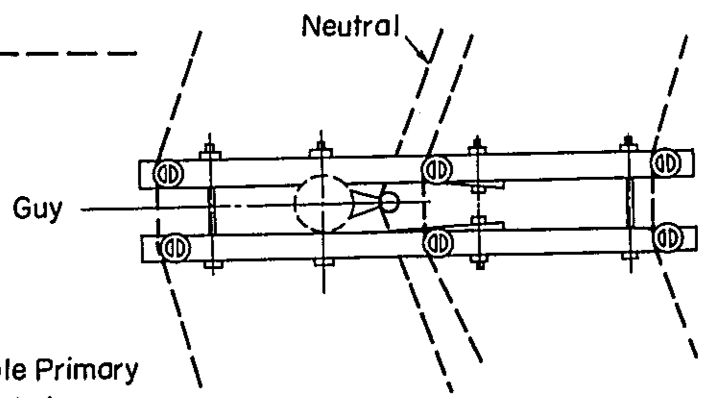
Fig.A-6-3 Details of Pole Dimension Diagram.

(7.62/13.2 kV, 3-phase)



0° to 5° Angle, Single Primary Support

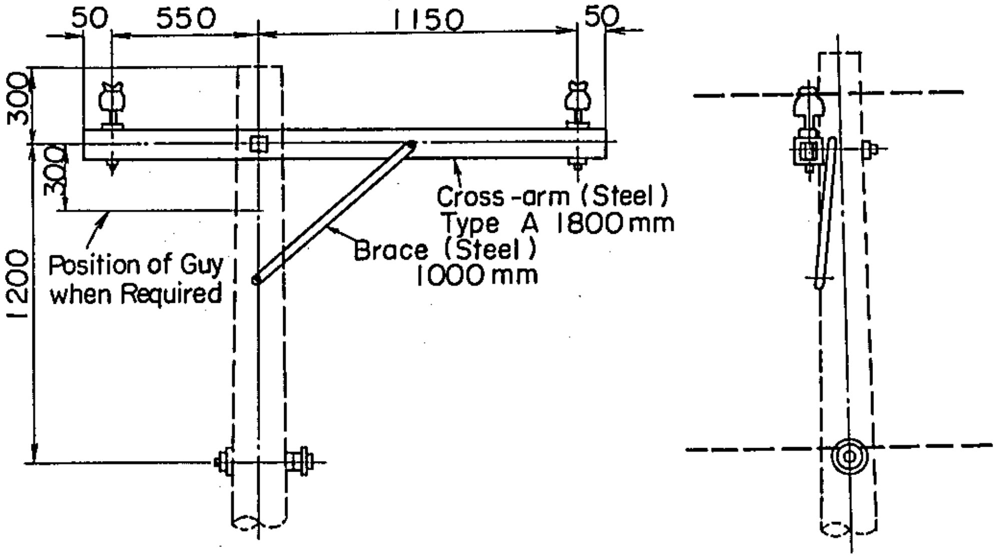




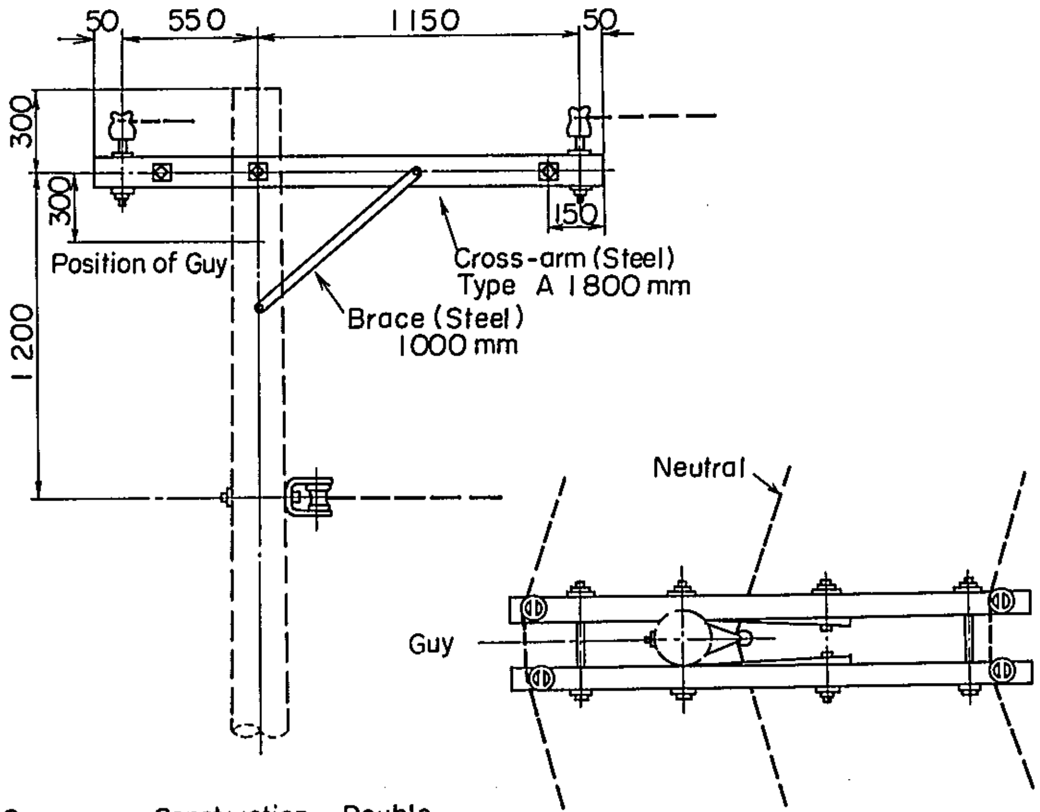
Crass-arm Construction - Double Primary Supports (5° to 30° Max. Angle)

Fig.A-6-4 Details of Pole Dimension Diagran.

(7.62 / 13.2 kV, 3- phase.)



0° to 5° Angle, Single Primary Support

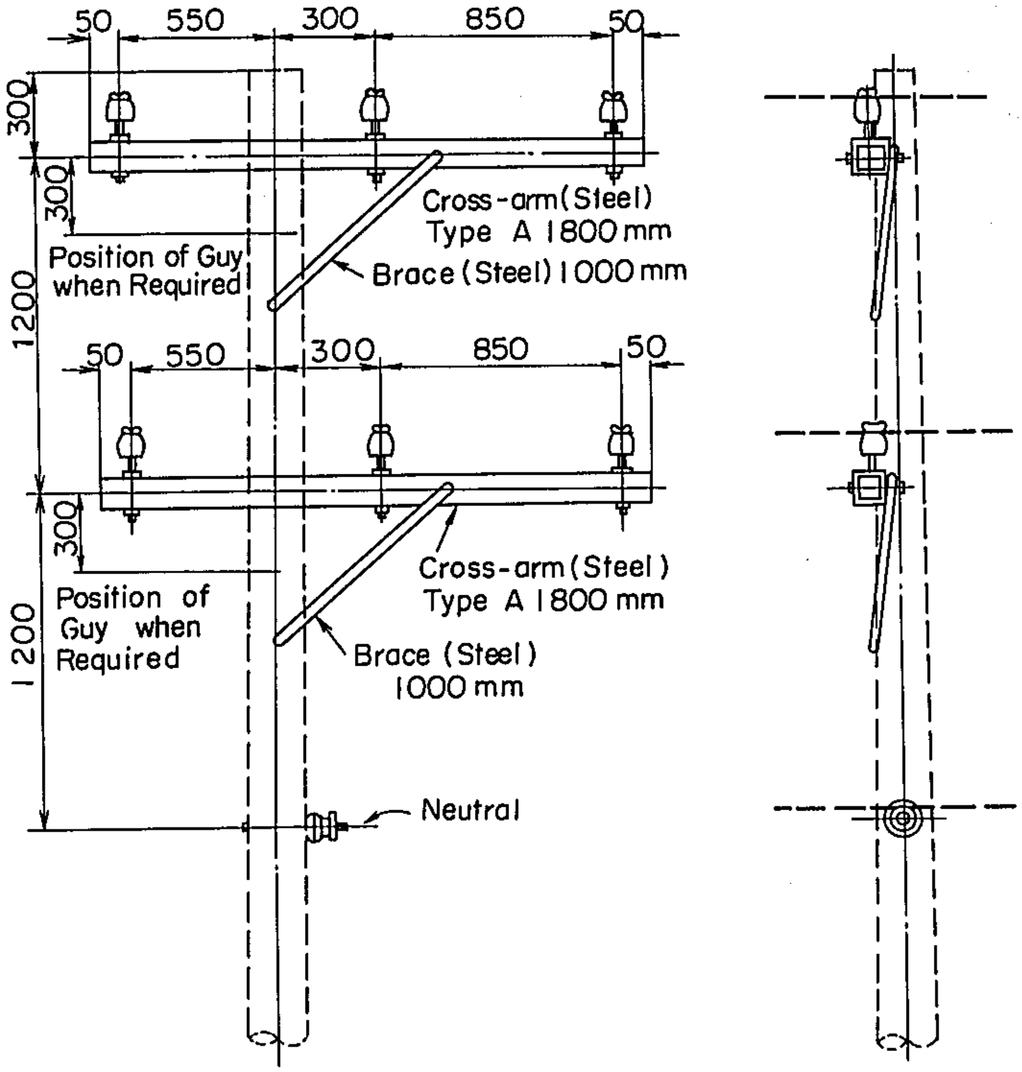


Cross-arm Construction - Double Primary Supports

(5° to 30° Max. Angle)

Fig.A-6-5 Details of Pole Dimension Diagram.

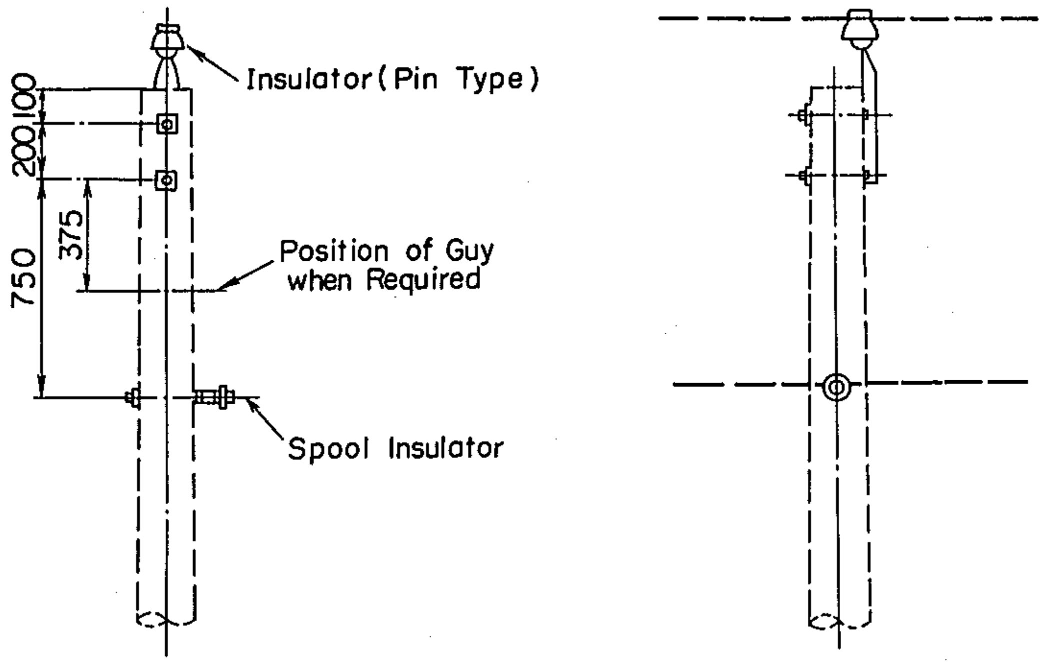
(7.62 / 13.2 kV, 3 - phase)



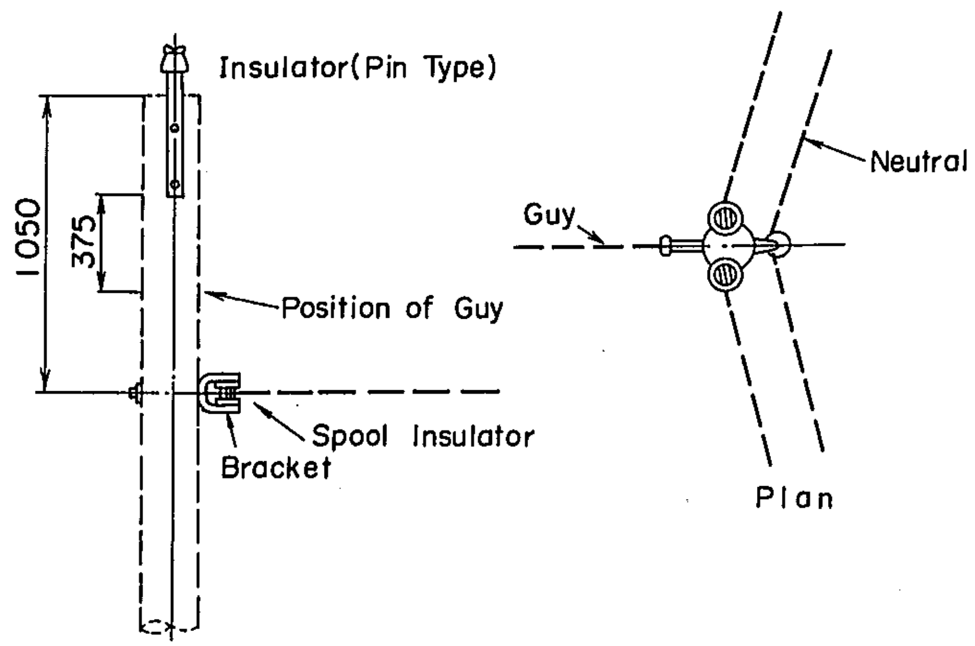
Cross-arm Construction - Double Circuit
Single Primary Support at 0° to 5° Angle.

Fig.A-6-6 Details of Pole Dimension Diagram.

(7.62 / 13.2 kV, Single phase.)



0° to 5° Angle , Single Primary Support



5° to 30° Maximum Angle, Double Primary Supports

Fig.A-6-7 Details of Pole Dimension Diagram.

(7.62 / 13.2kV, Two Transformers on 3-phase.)

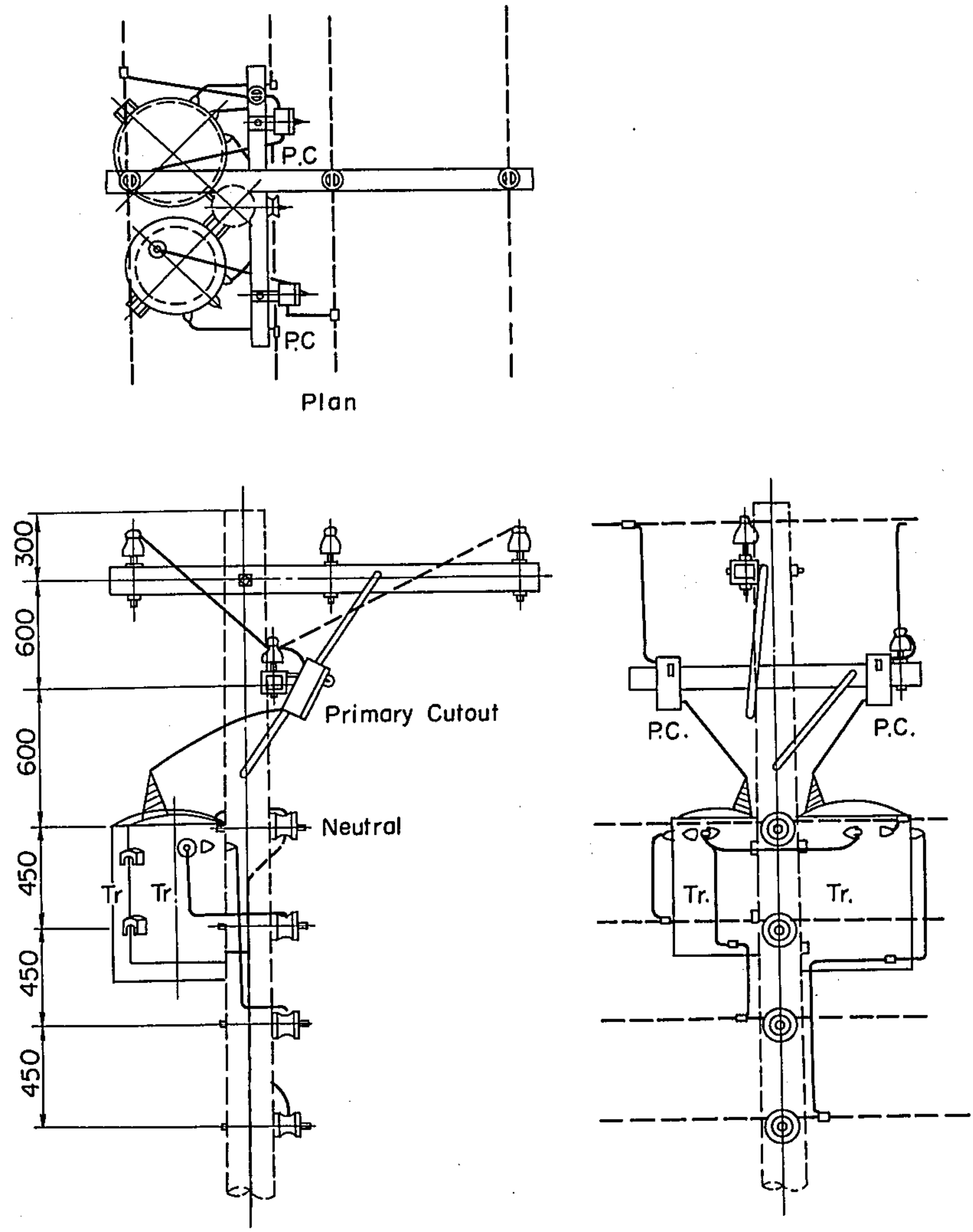
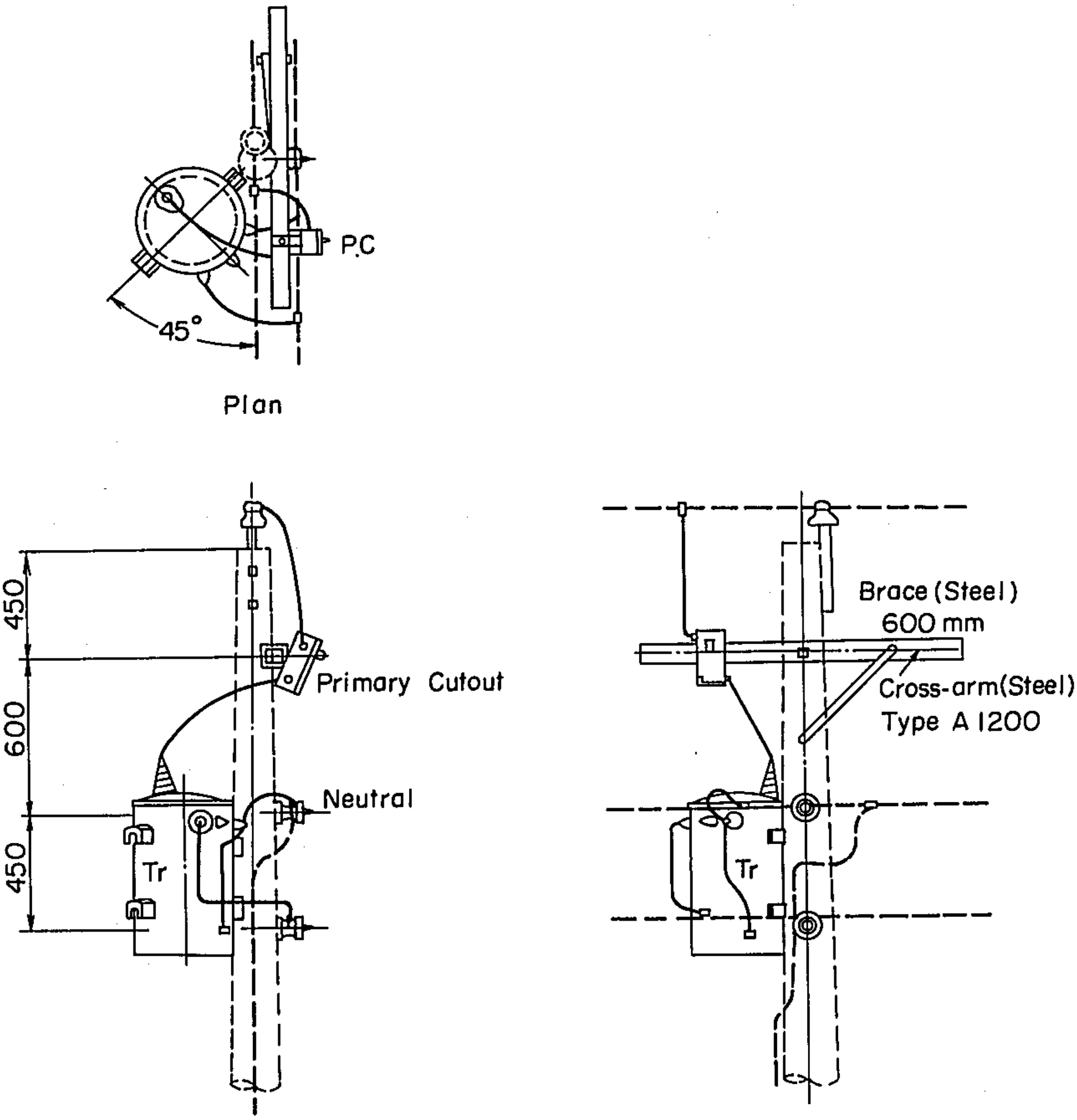


Fig.A-6-8 Details of Pole Dimension Diagram

(7.62 / 13.2 kV, Single Phase Transformer)



APPENDIX A-7

COST ALLOCATION OF 230kV TRANSMISSION LINE BETWEEN AMBUKLAO AND SANTIAGO

A-7 Cost Allocation of 230 kV Transmission Line between Ambuklao and Santiago

(1) Upon interconnection of the Magat Power Plant with the Cagayan Power System in 1981, most of power will be transmitted to the Central Manila Power System. Therefore, it is not appropriate that the proposed transmission facilities under this Project only bear all costs to be incurred in its construction, but in measuring the economy of the transmission line the cost should be allocated to the Magat Hydro Power Plant according to a suitable ratio commensurate with the benefits to be derived by the said power plant and the transmission line.

The "benefit" of the power plant has been obtained by multiplying the kW value and kWh value of an alternative thermal power plant shown in Table A-7-2 with the power requirement (kW) and energy requirement (kWh) of power transmittable to Manila through the Central Luzon Power System. Benefits of the Cagaya Valley transmission line have also been obtained by multiplying the above-mentioned values of the standard thermal power plant with the kW and kWh values obtained on the basis of the forecasted power demand in the Valley described in this study.

(2) As seen in Table A-7-1, in order to obtain a ratio of costs to be allocated between the Magat Hydro Power Plant and the transmission line, the benefits to be accrued in the respective years during the serviceable life of the facilities are converted into values in the beginning of 1978 at a discount rate of 12%. As a result of these tabulations, the allocation ratio to the Magat Hydro Power Plant is 75.3%.

Table A-7-1 Cost Allocation of Transmission Line between Ambuklao and Santiago

Items	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Magat P.S.										
Available power (MW)	-	-	-	200	300	300	300	300	300	300
Available energy (GWh)	-	-	-	922	991	991	991	991	991	991
Cagayan Valley										
Power requirement (MW)	23.5	27.7	31.0	34.5	38.7	43.8	47.7	52.3	56.9	61.4
Energy requirement (GWh)	107	126	139	154	170	189	205	222	240	258
Transmittable power and energy to Manila										
Power (MW)	-	-	-	165.5	261.3	256.2	252.3	247.7	243.1	238.6
Energy (GWh)	-	-	-	768	821	802	786	769	751	733
kW value 1/ (US$/kW)	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7
kWh value (mills/kWh)	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9
(1) Cagayan Valley										
kW value (10^3US$/kW)	744	878	982	1,093	1,226	1,388	1,512	1,657	1,803	1,946
kWh value (10^3US$/kWh)	1,808	2,129	2,349	2,602	2,873	3,194	3,464	3,751	4,056	4,360
(2) Power and energy to Manila										
kW value (10^3US$/kW)	-	-	-	5,246	8,283	8,121	7,997	7,852	7,706	7,563
kWh value (10^3US$/kWh)	-	-	-	12,979	13,874	13,553	13,283	12,996	12,691	12,387

Note: 1/ implies the figures derived from an alternative thermal power plant to Magat Power Station.

(continued)

Items	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
(1) Cagayan Valley										
Total value (10^3US$)	2,552	3,007	3,331	3,695	4,099	4,582	4,976	5,408	5,859	6,306
(2) Manila Grid										
Total value (10^3US$)	-	-	-	18,225	22,157	21,674	21,280	20,848	20,397	19,950
Discount rate (12%)	0.892	0.797	0.711	0.635	0.567	0.506	0.452	0.403	0.360	0.321
(3) Present value (10^3US$)										
Cagayan Valley	2,276	2,396	2,368	2,346	2,324	2,318	2,249	2,179	2,109	2,024
Manila Grid	-	-	-	11,572	12,563	10,967	9,618	8,401	7,342	6,403
(4) Total present value (10^3US$)										
Cagayan Valley	22,589 + (6,306 x 8.244 x 0.321) = 22,589 + 16,687 = 39,276									
Manila Grid	66,866 + (19,950 x 8.244 x 0.321) = 66,866 + 52,794 = 119,660									

Construction cost to be allocated to the Project $= \frac{39,276}{39,276 + 119,660} \times 100$

$= \frac{39,276}{158,936} \times 100 = 24.7\%$

Table A-7-2 Alternative Thermal Power Plant

Plant capacity (MW)	200
Plant factor (%)	70
Annual energy production (GWh)	1,230
Station service use (%)	5.0
Annual available energy (GWh)	1,170
Thermal efficienty at sending end (%)	35.7
Construction cost (thousand US$)	52,100
Foreign currency	42,700
Domestic currency	9,400
Serviceable life (years)	30
Annual cost (thousand US$)	
Fixed cost	
Amortization	5,210
Repair and maintenance	830
Annual salary	110
Miscellaneous cost	100
Administration cost	90
Subtotal	6,340
Variable cost	
Fuel cost	19,500
Repair and maintenance	210
Subtotal	19,710
Total	26,050
Fixed cost (US$/kW)	31.7
Variable cost (mills/kWh)	16.9
Total cost (mills/kWh)	22.3

Note: 9,650 BTU/kWh