No special technical difficulties will be encountered except for preparatory works for the construction road(s) in some areas.

(b) Substation

(i) Stage 1

The construction work of facilities required for the step-up substation in Stage 2 is to provide temporary connection from the new power plant to the transmission line in order to directly transmit power to Koror. The equipment to be employed for these provisional facilities is designed to be utilized mainly in the major facilities of the substations to be constructed in Stage 2.

(ii) Stage 2

In construction of the substations, foundations for the equipment will be constructed, equipment installed, cables drawn, connections made, and a number of tests performed, the tasks be carried out in that sequence. The heaviest equipment for the substation is the transformer, which is to be transported to the site by sea.

(c) Communication System

(i) Stage 1

In Stage 1, the base communication station will be established in the new and existing Malakal Stations. Mobile stations for the vehicles and the portable stations for the patrollers will also be provided. These stations will be used for exchange of information needed for operation and maintenance. The communication system can be effectively utilized also for communication in conducting the tests and construction works.

(ii) Stage 2

The base stations will be established at the step-down substation and in the maintenance office. The telecommunication system shown in the "Outline of the Project" will be used for more efficient operation and maintenance of the facilities included in the Project.

7-4 Procurement

All major materials, equipment and supplies to be procured for this Project are to be manufactured in Japan.

7-5 Maintenance and Management Plan

(1) Maintenance and Management System

The Government of Palau intends to shut down the existing Malakal Power Plant after test operation of the new facilities is made upon completion of this Project.

For this purpose, the said Government is contemplating assigning personnel currently engaged in the operation and maintenance of the existing facilities plus some of new exployees to such work of the new facilities. Necessary on-the-job training for these personnel is as described in 6-7. It is arranged that IPSECO will render technical services for the operation and maintenance of the facilities after an elapse of the training period.

(2) Cost of Operation and Maintenance

The cost of operation and maintenance of the power system is calculated and presented in the economic analysis in 8-1. It is expected that the cost, including the maintenance cost of the power plant which is currently borne by the Government, will be substantially reduced as compared with an alternative that Malakal Power Plant would continue to be in operation.

(3) Procurement of Fuel

It will be a matter of importance to ensure storage of fuel for the smooth operation and maintenance of the facilities after completion of the Project. The Government of Palau intends to sell such fuel through a joint enterprise to be established by the said Government and IPSECO. Since it is arranged that fuel for the new power plant will be purchased from the above-mentioned enterprise, it is essential that supply of such fuel be smoothly made for the efficient operation and maintenance of the new power plant.

CHAPTER 8

PROJECT EVALUATION

Chapter 8 Project Evaluation

8-1 Economic Analysis

(1) Generating Cost of Malakal Power Plant

The existing Malakal Power Plant is aged, as described before, and the Government of Palau reported that it is being operated at a high generating cost. According to the estimate made by the Government of Palau, the generating cost of the plant, based on figures for fiscal 1983, was 22 cents/kWH.

Generating Cost of Malakal Power Plant
calculated by Government of Palau

(for fiscal 1983)

Personnel expense	$326,300
Cost of oil	$2,742,600
Fuel cost	$2,637,000
Lubrication oil	$105,600
Repairing expense	$307,200
Total expense	$3,376,100 ..... [A]

Power generation (12 monthly generation)

1,284.6 MWH x 12 = 15,415 MWH ..... [B]

Generating cost ([A]/[B]) = $0.219/kWH ..... 22 cents/kWH

The cost did not include the capital cost, such as the depreciation of capital goods including equipment, or interest.

Although there is not sufficient data for determining the generating cost, and the authentic calculation of the generating cost is difficult, the Team has calculated such a figure for 1984 based on the above-mentioned figure for the previous year and obtained a presumable cost of 22 cents/kWH, which is identical with 22 cents/kWH estimated by the Palau side.

Presumed Generating Cost for Fiscal 1984

Personnel expense	$342,600
Cost of oil	$2,726,700
Fuel cost ($0.98/gal., 2,592,000 gal.)	$2,540,200
Lubrication oil ($5.18/gal., 36,000 gal.)	$186,500
Repairing expense	$505,100
Total expense	$3,574,400 ..... [A]
Power generation	16,406.5 MWH ..... [B]

Generating cost ([A]/[B]) = $0.218/kWH .... 22 cents/kWH

The depreciation is not taken into account as the costs of the facilities and equipment are unknown. The personnel expense was assumed to be up 5% over the 1983 value, and other figures are the actual values in fiscal 1984. In calculating the repairing cost, it is assumed that an overhaul is performed once in three and a half years, based on a report of the Government of Palau, and calculated as below for the years without overhaul and with overhaul, respectively.

Repairing expense for the year without overhaul = $307,200 (based on the record in 1982)

Repairing expense for the year with overhaul = $1,000,000 (based on the record in 1984)

Average repairing cost

= $505,100 (=[($307,200 x 2.5 years + $1,000)/3.5 years]

(2) Generating Cost of Aimeliik Power Plant

The construction of the new power plant being built in Aimeliik State under contract with IPSECO, as described before, and scheduled to be completed by June 1985. The total construction cost of the plant is $28,965,800, including the construction cost of an oil tank facility (with 8 tanks with a total capacity of approximately 6 million gallons). The construction cost of the tank facility is presumed to be 6 million dollars.

The fund for construction of the plant, 32.5 million dollars, is financed by a credit of 24.3 million dollars supplied by ECGD (Export Credits Guarantee Department) of Britain, and a loan of 8.2 million dollars at a LIBOR rate (London Interbank Offered Rate). The difference between the total fund required and the borrowed money, 3.5 million dollars, is reported to be the interest plus the fund for the maintenance and management of the power plant and for personnel training, on contract with IPSECO. The oil tank facility, of which construction cost is included in the plant construction cost above, is to be used as an oil storage facility for the power plant and marine

ships. The Government of Palau and ISPECO jointly financed and established a subsidiary (at a ratio of 75 to 25) for the purchase and sales of oil, and it is planned that this subsidiary will operate the said oil facility. Although the Team was not informed by the Government of Palau of the specific business plan of the subsidiary, it is concluded that the construction cost of the tank facility should be excluded from the calculation of the power generating cost, since operation of the tank facility will be independent of the power supply business.

The Government of Palau explained that, there is a power plant constructed by IPSECO in the Marshall Islands, having the same specification and similar size as Aimeliik Power Plant. Since the generating cost of the power plant in the Marshall Islands is from 7 to 8 cents/kWH, the cost of the new power plant in Palau should be almost the same. However, no materials or detailed information on the generating cost were available. Thus a detailed evaluation of the generating cost of the new power plant is difficult. The average generating cost has been calculated as follows according to a standard practice employed in Japan.

The basis for the calculation is as explained in Appendix 8-1.

Average Generating Cost of Power System of Aimeliik Plant

Annual power generation	48,287.7 MWH	[A]
(15 year average)		
Construction cost	$22,965,800	[B]
Annual expense	(in U.S. dollars)	
Capital cost	2,363,500	
Direct expense	1,115,100	
(Repairing expense)	459,300	
(Miscellaneous expenses)	91,900	
(Personnel expense)	447,600	
(Lubrication oil)	116,300	
Fuel cost	2,241,600	
Total annual expense	5,720,200	[C]
Total annual expense minus capital cost	3,356,700	[D]
Generating cost		
Including capital cost [C]/[A]	12 cents/kWH	
Excluding capital cost [D]/[A]	7 cents/kWH	

The average generating cost of the new power plant is as shown in the table above. The generating cost excluding the capital cost is 7 cents/kWH, which is practically identical with that of the power plant

in the Marshall Islands which was explained by the Government of Palau as being 7 to 8 cents/kWH. The generating cost, including the capital cost, is 12 cents/kWH, which is below the generating cost of the existing power system, 22 cents/kWH.

In determining the generating cost of the power system of the new power plant, the depreciation can not be taken into account unless the Government of Palau accepts a concept of depreciation. It should be more reasonable and practical, however, to assume; that the repayment of the principal for the construction of the power plant is the direct cost which is to be borne by the Government of Palau in connection with the construction works, and that thus an expense of the repayment and interest should be included in the generating cost as the capital cost. Although the opinion of the Government of Palau was that the government can depend on the financial assistance of the United States for the repayment of the loan, it should be reminded that even the United States would not provide an extra fund, in addition to the annual financial assistance, for the repayment of the loan. In case the generating cost of the new power plant is 12 cents/kWH on the average, 22 cents/kWH of the Malakal Power Plant and 12 cents/kWH of the new power plant will be based on the same calculation basis. On the above-mentioned assumption, studies will be made on an amount of the financial burden to be shouldered by the Government of Palau because of the difference between the generating cost and power sales rate.

(3) Comparison of Generating Cost in Old and New Power Systems

According to the calculation above, the cost of power generation is reduced by 10 cents per kWH (22 cents/kWH to 12 cents/kWH) when the power supply is shifted from the old power system to the new power system. Based on the recorded amount of the annual power generation of 16,406.5 MWH in 1984, the total generating cost of the existing power system will be reduced by 1,640,000 dollars annually.

Comparison of Annual Generating Cost

Annual generating cost of existing power system:

16,406,500 kWH x 22 cents = $3,609,400

Annual generating cost of new power system:

16,406,500 kWH x 12 cents = $1,968,800

Saving: $1,640,600

If comparison is made on the generating cost between the old and new power systems with regard to an average annual energy production in the coming 15 years on the assumption that the useful life of the equipment and facilities is to be 15 years, it will be possible to save approximately 4,170,000 dollars per annum in the next 15 years.

Average annual generation:

° Let the average annual generation in the calculation of the power generation of the new power plant be 48,287.7 MWH.

° Let the maximum generation of the existing power plant be 41,697.6 MWH (On the assumption that 7 out 8 generators are normally operated, and the average load factor is 70%. Generation = (8,000 - 1,200) kW x 70% x 24 x 365 = 41,697.6 MWH.

° In case the quantity of power generated exceeds a value of 41,697 MWH, the generating cost of the existing power plant is used the cost of the new power plant (12 cents/kWH)

Comparison of annual generating cost:

Annual generating cost of existing power system:

41,697.6 MWH x 22 cents = $9,173,500

6,590.1 MWH x 12 cents = $790,800

Total = $9,964,300

Annual generating cost of new power system:

48,287.7 MWH x 12 cents = $5,794,500

Saving = $4,169,800

As may be seen from the above, if the power being generated by the existing system is supplied by the new power plant, the generating cost will be reduced at a rate of approximately 1,640 thousand dollars per year. If the average power generation required for the next 15 years is kept on being supplied by the existing system, it will be more expensive than power supply from the new system at a rate of 4,170 thousand dollars per year.

Thus the financial burden now being placed on the Government of Palau will be substantially decreased when power supply is made from the new power system. In addition, the industrial and economic development to be stimulated by this Project, and a variety of side effects will increase the revenue of the Government of Palau.

(4) Reduction in Government Expenditure

(a) Comparison of the Government financial burden including electric power revenue

The electricity sales revenue of the Government in 1980 and subsequent years is as shown in the following table.

Fiscal Year	Electric Power Sales Revenue (in 1,000 dollars)
1980	632.4
1981	696.1
1982	705.1
1983	not clear
1984	not clear

Although the power sales revenue of the Government after 1983 is not exactly known, the revenue in 1984 can be surmised as being 1,026.6 thousand dollars, by subtracting the government consumption of 5,000 MWH from the total power generation of 16,406 MWH. [(16,406.5 MWH - 5,000 MWH) x 9 cents)]

Thus the electric power sales revenue of the Government in fiscal 1984 can be surmised as approximately 1 million dollars. From this figure, the expenditure of the Government on the electric utility operation can be calculated as approximately 2,610 thousand dollars. [Annual generating cost (16,406.5 MWH x 22 cents) - revenue from electricity charges] If the power is supplied by the new power system, this government expenditure will be approximately 970 thousand dollars, or a reduction of 1,630 thousand dollars. [Annual generating cost (16,406.5 MWH x 12 cents) - revenue from electricity charges]

Assuming that the present rate of electricity is unchanged, as there is no plan for revision of the electricity tariffs on the part of the Government, and based on the average annual generation for the next 15 years (48,287.7 MWH), the Government expenditure will be reduced by 4,170 thousand dollars annually by operation of the new power system, of which the reduction of the expenditure from 1984, due to increase in the electricity generation (2.9 times), will amount to 420 thousand dollars per year.

Detail explanation is as follows:

At present the Government of Palau has no concrete plan for revision of the electricity tariffs. Accordingly, if the present tariffs remain unchanged, the financial burden on the part of the Government of Palau will be as described below, provided, however, that the new power plant is to generate an energy production of 48,287.7 MW on the average per annum in the coming 15 years. Government-owned offices and facilities consume 30% of the total energy consumption. Therefore, the value is calculated to be 4,000 kW x 0.7 (load factor) x 0.3 = 840 kWH/h.

As stated in 5-2-(3)-(b), incremental power demand to arise from the above-mentioned government offices and facilities is estimated at 610 kW after 10 years. With a load factor of 70% on the average for a period of 10 years, increase in energy consumption will be 427 kWH/h on which basis an average figure of 42.7 kWH/h $(\frac{427 \text{ kWH/h}}{10 \text{ years}})$ per year can be obtained. The energy consumption in the 10th year from the present will reach 1,267 kWH/h comprising 840 kWH/h plus 427 kWH/h. Consequently, the annual rate of

increase in energy consumption is calculated to 3.4% ($\frac{42.7 \text{ kWH/h}}{1,267 \text{ kWH/h}}$). In the event that this rate is also maintained for another five (5) years, the energy consumption for the 15 years will be 8,284.3 (945.7 kWH x 8,760) MWH on the average per year.

In case the maximum energy generation by the existing power plant is 41,697.6 MWH per year and a generating cost of 12 cents per kWH is assumed to be applied to capacity in excess of 41,697.6 MWH/year, the financial burden to be borne by the Government of Palau will be;

Financial burden in case of the new power system

Revenue:	(48,287.7 MWH - 8,284.3 MWH) x 9 cents	= $3,600,300
Generating cost:	48,287.7 MWH x 12 cents	= $5,794,500
Cost borne by the Government:		= $2,194,200

Financial burden in case of the existing power system

Revenue:		$3,600,300
Generating cost:	41,697.6 MWH x 22 cents + (48,287.7 - 41,697.6) MWH x 12 cents	= $9,964,300
Cost borne by the Government:		$6,364,000

Thus an extra expenditure of approximately $4,170,000 ($6,364,000 - $2,194,200) must be borne by the Government annually, if future power demand is met by the existing power plant.

(b) Comparison of the Government Financial Burden in Following 10 Years

The balance of income and expenditure in the electric power system operation by the Government of Palau until 1995 has been calculated, based on the power requirement for the coming 10 years and in respect of the cases of the new and old power systems. The said balance for the next 10 years is as indicated in Table 8-1.

As may be seen from the table, the accounts of the electric power system operation runs on deficits for the early period of the new power system, mostly due to repayments of the loans. But the deficit decreases every year, and net earnings will be obtained in fiscal 1993 and subsequent years.

If, on the other hand, the old power system is used, the amount of deficit increases year by year as the power generation increases because of its high generating cost.

Table 8-1 Comparison in the Movements in the Balance of Revenue and Expenses From the Power Project to the Goverment Financial Affiers in 1985 to 1995

(Unit : US$ 1,000.-)

	Annual Amount Generated Power	Annuall Gov. Consumption	Revenue from the Power Project		The Burden to the Finance by usage of new Power Plant				The Burden to the Finance		(Ⓔ - Ⓖ) The Comparisons in the Burden to the Finance(※3) by New and Existing System
	Ⓐ (MWH)	Ⓑ (MWH)	Amount of Power sold (MWH)	Ⓒ Revenue	Generation Cost (※1)(B x 7 cents)	Repayments to the loan	Total Cost to Ⓓ Generate Power	The Burden to Gov. Ⓔ (Ⓒ - Ⓓ)	Ⓕ (※2) Generating Power Cost	Ⓖ (Ⓒ - Ⓕ) The Burden to the Fin	
FY 1985	0 / 24,528.0	7,358.4	0 / 17,169.6	0 / 1,545.3	0	△7,066.2	7,066.2	△7,066.2	5,396.2	△3,850.9	△3,215.3
1986	13,797.0 / 27,594.0	3,866.3 / 7,732.5	9,930.8 / 19,861.5	893.7 / 1,787.5	965.8	6,172.6	7,138.4	△6,244.7	6,070.7	△4,283.2	△1,961.5
1987	30,660.0	8,106.5	22,553.5	2,029.8	2,146.2	4,168.5	6,314.7	△4,284.9	6,745.2	△4,715.4	430.5
1988	33,726.0	8,480.6	25,245.4	2,272.1	2,360.8	3,872.5	6,233.3	△3,961.2	7,419.7	△5,147.6	1,186.4
1989	36,792.0	8,854.6	27,937.4	2,514.4	2,575.4	3,569.4	6,144.8	△3,630.4	8,094.2	△5,579.8	1,949.4
1990	39,858.0	9,228.7	30,629.3	2,756.6	2,790.1	3,269.8	6,059.9	△3,303.3	8,768.8	△6,012.2	2,708.9
1991	42,924.0	9,602.7	33,321.3	2,998.9	3,004.7	2,801.2	5,805.9	△2,807.0	9,320.6	△6,321.7	3,514.7
1992	45,990.0	9,976.8	36,013.2	3,241.2	3,219.3	1,296.2	4,515.5	△1,274.3	10,117.8	△6,876.6	5,602.3
1993	49,056.0	10,350.8	38,705.2	3,483.5	3,433.9	0	3,433.9	49.6	10.792.3	△7,308.8	7,358.4
1994	52,122.0	10,724.9	41,397.1	3,725.7	3,648.5	0	3,648.5	77.2	11,466.8	△7,741.1	7,818.3
1995	55,188.0	11,098.9	44,089.1	3,968.0	3,863.2	0	3,863.2	104.8	12,141.4	△8,173.4	8,278.2

Assumptions

(※1) New Power Plant System will be operated in April 1986.

(※2) The Generating Power Cost by the use of the Existing Power Plant System

- Average load factor as 70 %. the Maximum amount of power will be generated by 7 units of plant out of 8 (8,000 − 1,200) kW x 70 %. x 24 x 365 = 41,697.6 MWH / year
- Therefore cost will be 22 cents/kWH up to 41,697.6 MW, for Exceeding amount of 41,697.6 MWH, the cost is 12 cents/kWH which obtained from the averag generating power cost of new Power Plant System.

(※3) The Comparison in the Burden to the Goverment Financial Affiers by the New and Existing Power Plant System Ⓔ-Ⓖ for the cost of the Burden to the Finance

- △ indicate in Case of the New Power Plant System Excees Amount of cost to the Burden to the Finance Compare to the one from the Existing Power Plant System

No-mark indicate less amount of Burden to the Finance by Comparison in the New and Exiseting Power Plant System

The expenditure by the Government will be smaller until fiscal 1986 than the case that the new power system is employed, but from 1987 onward, the financial burden on the Government will be smaller in case of the new power system, and the difference in merits between the two systems increases year after year.

As a consequence, it can be concluded that introduction of the new power system will be more advantageous for the interests of the Government of Palau in the financial aspects, if comparison are made on the financial burdens of the Government of Palau in both cases of the old and new power systems.

8-2 Benefits and Effects on National Level

This Project will contribute to a stable supply of electricity from the new power plant, which in turn will:

(1) Stabilize and vitalize the private industries by making it possible for the consumers to switch from the expensive self-generating facilities to the power supplied by the government at a lower cost.

(2) Enhance the welfare of people living in the area to which the electrification is introduced.

(3) Vitalize economic and social activities in general by creating new electric demands.

(4) Create employment by economic development, and enhance the productivity and income of labor.

(5) Stimulate the movement of the population and eliminate the problem of concentrated population distribution.

The direct benefits and effects of the Project upon creation of new electric demands will reduce power generation costs in the long run. This will also lessen the financial burden of the Government. Moreover, the stable electric supply at a low cost will encourage development of industries, and at the same time, saving in the government expenditure will make it possible to increase to spend more money upon education and welfare. It is thus expected that those cumulative effects on both private and public sectors will have substantial impacts upon increase in labor productivity and enhancement of the livelihood of people in general.

8-3 Benefits and Effects on Regional Level

This Project will provide particular benefits for people who are supplied with electricity by:

(1) Relieving consumers from inconvenience and uneasiness with the supply of stable electric power.

(2) Enhancing living standards, educational level, medical care and improving security of people presently living in the areas without electrification.

(3) Vitalizing local communities by introducing convenience and information.

CHAPTER 9

CONCLUSIONS AND RECOMMENDATIONS

Chapter 9 Conclusions and Recommendations

9-1 Conclusions

This Basic Design Study Report has been compiled upon analysis of the results of the field surveys regarding the present situation of the existing electric power system, places designated as future development areas and sites, and the construction progress of the new power plant in Aimeliik State, Babelthuap and in due consideration of the outcome of discussions made with officials concerned with the Project of the Government of Palau. The following conclusions could be enumerated:

(1) Since the existing electric power generating facilities are superannuated and frequent failures take place, a stable supply of electric power is not regularly made.

(2) A power supply from the new power plant will be more economical in the long run, which will enable the financial burden of the Government of Palau to be lessened.

(3) The construction by IPSECO of the new power plant currently being financed by proceeds from British loans and is to be completed in June 1985. Accordingly, it is essential that construction of the transmission line be commenced as soon as possible for the purpose of sending required electric power from the said power plant to the load areas in Koror.

(4) The results of the field surveys indicate that technical difficulties will hardly be raised in the implementation of the Project.

(5) It is considered that a stable supply of electric power will contribute to vitalization of economic and industrial activities in Palau and enhancement of the welfare of inhabitants as well as improvements of the people's livelihood.

If the above conclusions are taken into account, it is judged that the implementation of the Project will be quite significant. It is, therefore, considered justifiable for the Government of Japan to render Grant Aid for the purposes stated hereinabove.

9-2 Recommendations

As the transmission and distribution system to be constructed under this Project will provide a basis for the future development of Palau, the following two points should be considered so that their functions can be maintained for a long time.

(1) Upon completion of the Project, the facilities should be maintained according to a systematic maintenance program in order to firmly ensure the highly reliable supply of electricity. For this purpose, it will be essential that basically required tech-

nical know-how and experience of operation and maintenance be acquired by personnel concerned through on-the-job training to be provided by a Japanese consulting firm and/or contractor(s) during the construction of the Project and thereafter through technical services to be provided by IPSECO.

(2) It is recommended that the Government of Palau revise the present electricity tariffs to such an extent that the generating cost and electricity sales revenue can be balanced for eliminating the chronical deficits in their account. In working out new electricity tariffs, it is recommended that respective rates for different categories of consumers be determined. It is also essential that a manner of collecting electricity charges from government offices and facilities consuming electricity be examined. Consequently, it is desirable to set up an independent electricity rate even if "out-going" and "in-coming" proceeds are in the same financial source.

Deliberate attention should be given to the revision of the present electricity tariffs lest industrial development including attraction of enterprises should be impeded.

APPENDIX

APPENDIX

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	3-2-(1) (2)	GEOLOGIC DATA
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	6-5	LAYOUT FOR STEP-UP SUBSTATION
	6-6	LAYOUT FOR STEP-DOWN SUBSTATION
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	6-8	SINGLE LINE DIAGRAM OF TEMPORARY TRANSMISSION SCHEME
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	8-2	DETAILS OF THE LOANS FROM BRITISH BANKS

KEY PERSONNEL WITH WHOM STUDY TEAM MET

1. Key Personnel with whom Study Team Met

(1) Government of Palau

Mr. Alfonso R. Oiterong	Vice President and Minister of State

(2) Ministry of National Resources

Mr. koichi L. Wong	Minister
Mr. Marselino Melailrei	Director Bureau of Public Works
Mr. Juan F. Polloi	Physical Planner, Division of Design and Engineering Bureau of Public Works

(3) Ministry of State

Mr. Ramon Rechebei	Chief, Division of International Trade State Department Bureau of Foreign Affairs

(4) Office of Planning and Statistics

Mr. Gerard P. Geossens	United Nations General Statistics Expert
Mr. Mirza S. Rahman	United Nations Associate Expert

(5) IPSECO International Systems Ltd.

Mr. Mark Kaye	Project Manager
Mr. Doug F. Dulcamara	Projects Manager

(6) Consulate General of Japan in Agana

Mr. Y. Nagashima

STUDY TEAM

Mr. Toshichika KUROKI	Team leader (Ministry of International Trade and Industry)
Mr. Naoyoshi SASAKI	Project Coordinator (Japan International Cooperation Agency)
Mr. Takeshi ICHIKAWA	Transmission and Substation Planning Engineer (EPDC International Limited)
Mr. Takao HORI	Distribution Planning Engineer (EPDC International Limited)
Mr. Koji KOJIMA	Substation Design Engineer (EPDC International Limited)
Mr. Toshihiko MITSUDA	Civil Engineer (EPDC International Limited)
Mr. Shigeo ISHI	Project Economist (EPDC International Limited)

ITINERARY

Date	Day of week	Description	Attendants
Jan. 9	Wed.	Leave Tokyo and arrive in Guam Courtesy Call at Consulate General of Japan	
		Briefing of Preliminary Study and Inception Reports	Consul General
Jan. 10	Thu.	Leave Guam and arrive in Koror	
		Courtesy Call at Vice President Office	Vice President Minister of National Resources
		Briefing of Inception Report Discussion on Study Schedule Briefing of Questionnaire	Director, Bureau of Public Works Physical Planner, Division of Design and Engineering Chief, Division of International Trade Project Manager, IPSECO
Jan. 11	Fri.	Discussion on Questionnaire	Vice President Minister of National Resources Director, Bureau of Public Works Physical Planner, Division of Design and Engineering
		Site survey of Malakal Power Plant	
Jan. 12	Sat.	Data analysis of Operational Report on Malakal P.P.	
Jan. 13	Sun	Site Survey on existing electric facilities in Airai State	
Jan. 14	Mon.	Site Survey on Transmission line Route (A Route) and New Power Plant.	Physical Planner, Division of Design and Engineering
		Collection of Data on National Development Plan	

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Date	Day of week	Description	Attendants
Jan. 15	Tue.	Site Survey on Transmission Line Route (Route B)	Physical Planner, Division of Design and Engineering
Jan. 16	Wed.	Discussion on Site Survey Results	Minister of National Resources Physical Planner, Division of Design and Engineering
Jan. 17	Thu.	Discussion on Demand Forecast and Transmission Line System	Minister of National Resources Physical Planner, Division of Design and Engineering
Jan. 18	Fri.	Discussion on Questionnaire and Minutes of Meeting	Minister of National Resources Physical Planner, Division of Design and Engineering
Jan. 19	Sat.	Site Survey on Transmission Line and Electrification Area	Physical Planner, Division of Design and Engineering
Jan. 20	Sun	Preparation of Minutes of Meeting	
Jan. 21	Mon.	Signing of Minutes of Meeting	Minister of National Resources Physical Planner, Division of Design and Engineering
		(Messrs. Kuroki and Sasaki)	
		Leaving Koror and arrive in Guam	
		Courtesy Call at Consulate General of Japan	Consul General
		Briefing of the study result.	
		(Others)	
		Site Survey on New Power Plant	

Date	Day of week	Description	Attendants
Jan. 22	Tue.	(Messrs. Kuroki and Sasaki) Leave Guam and arrive in Tokyo (Others) Survey on Electrification Area, Construction Site and Economic Situation	Physical Planner, Division of Design and Egnineering
Jan. 23	Wed.	- ditto -	Physical Planner, Division of Design and Engineering
Jan. 24	Thu.	Discussion on Survey Results	Physical Planner, Division of Design and Engineering
Jan. 25	Fri.	Site Survey on Transmission Line Discussion on Construction Condition	Physical Planner, Division of Design and Engineering
Jan. 26	Sat.	Data Sorting	
Jan. 27	Sun.	Collection of Data on Malakal Power Plant	
Jan. 28	Mon.	Final Discussion on Data and Information Leave Koror and arrive in Guam	Minister of National Resources Physical Planner, Division of Design and Engineering
Jan. 29	Tue.	Leave Guam and arrive in Tokyo	

REPUBLIC OF PALAU
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MINISTRY OF NATIONAL RESOURCES

MINUTES OF DISCUSSIONS

In response to a request made by the Government of the Republic of Palau, the Government of Japan through Japan International Cooperation Agency (JICA), dispatched from January 10 to 29, 1985 to the Republic of Palau a Basic Design Study Team, headed by Mr. Toshichika Kuroki to gather pertinent information necessary for the design of the Babelthaup Electrical Power Transmission Line Phase I Project. The Team while in Palau, conducted field surveys to ascertain field conditions of the proposed electrical transmission line corridor, discussed with cognizant officials and reviewed existing reports and statistical data to develop design criteria applicable to the project, made projection of future electrical power demand for the proposed electrification area within the design period and cost estimate for the project.

As a result of the study, both parties have agreed to recommend to their respective Governments to further consider the attached statements of understanding toward the realization of the project.

Toshichika Kuroki
Toshichika Kuroki
Team Leader, JICA's
Basic Design Study Team

Koichi L Wong
Koichi L. Wong
Minister of National Resources
Republic of Palau

Date Jan. 21. 1985

Date JANUARY 21, 1985

REPUBLIC OF PALAU

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MINISTRY OF NATIONAL RESOURCES

STATEMENTS OF UNDERSTANDING

1. The design period for Babelthaup Electrical Power Transmission Line Phase I Project covers ten years from 1985 to 1995.

2. Based on a study conducted by JICA's Basic Design Study Team which took into consideration the estimated population growth, potential commercial and industrial developments and social advancement in the Republic of Palau during the design period, it is concluded that the electrical power demand in the country will reach no less than 9,000 KW by 1995. See Annex I.

3. From preliminary indications, Route B seem most preferable for part of the main electrical power transmission line. See Annex II.

4. The scope of the Babelthaup Electrical Power Transmission Line Phase I Project includes the following: An appropriately sized transformer substation (13.8 KV step-up to 34.5 KV) to be located at the Aimeliik power station; electrical power transmission lines originating at the step-up substation and extended through the Nekken Forestry station where one of the feeder terminates and the other continues through (possibly Route B) where the voltage drops through an appropriately sized transformer substation (34.5 KV step-down to 13.8 KV) and integrated with the existing Koror-Airai power system; provision of appropriate electrical power transmission lines (probably at a lower voltage than the proposed 34.5 KV main power transmission line) to the community of Mechebechubl in Ngatpang State and the communities of Mongami, Ngchemiangel, Medorm, Nekken, OISCA Training Center and Elechui, all of Aimeliik State; and, provision of certain electrical equipment and materials to be installed by the Republic of Palau.

5. Typical design criteria applicable to the project are shown in Annex III, IV and V.

6. The Government of the Republic of Palau shall be responsible for upgrading the existing Koror-Airai 13.8 KV electrical power transmission system to be compatible with the 34.5 KV Aimeliik-Airai power transmission line when the demand for electrical power approaches 9,000 KW which is estimated to take place by 1995.

7. The JICA Basic Design Team will convey to the Government of Japan that the Government of Palau will cooperate to the fullest by providing services and/or undertakings outlined in Annex VI to ensure that the project will be implemented in the most economical and expeditious manner.

Annex I

ELECTRIC POWER REQUIREMENTS IN THE PROJECT AREA BY 1995

A.	Use excluding residential in Koror	2580 KW
B.	Residential use in Koror	2920 KW
C.	New electrification area	130 KW
D.	Additional requirements except for residential use	3370 KW
	Total	9,000 KW

(Note)

1. Present electric power use ..... 4,000 KW
2. Assumption of residential use by 1995:
   - (a) Population projection (present) 12,180
     (by 1995) 12,725
     (increase) 545
   - (b) Average residents per house in Palau:
     (population) 12,180
     (number of houses) 2,265
     (average residents per house) 5.4
   - (c) Increase of houses in Palau: 110 (545/5.4)
   - (d) Increase of houses in the project area: ..... 75 (2/3 of 110)
     (Koror) 40
     (other area) 35
   - (e) Average electric power usage:
     (Koror) ..... 2 KW per house
     (other area) ..... 1 KW per house
3. Item B and C above include the increase of houses - 40 houses in Koror and 35 houses in the electrification area.
4. Item D includes the present power requirements not receiving power from the Government system and the estimated demands in future, such as the increase of demands except for residential use and and the requirements from Grace Hotel, Airport terminal, MIC, Van Camp, Palau Pacific Resort, New National Hospital, new sewage lift stations and so on.

Annex II

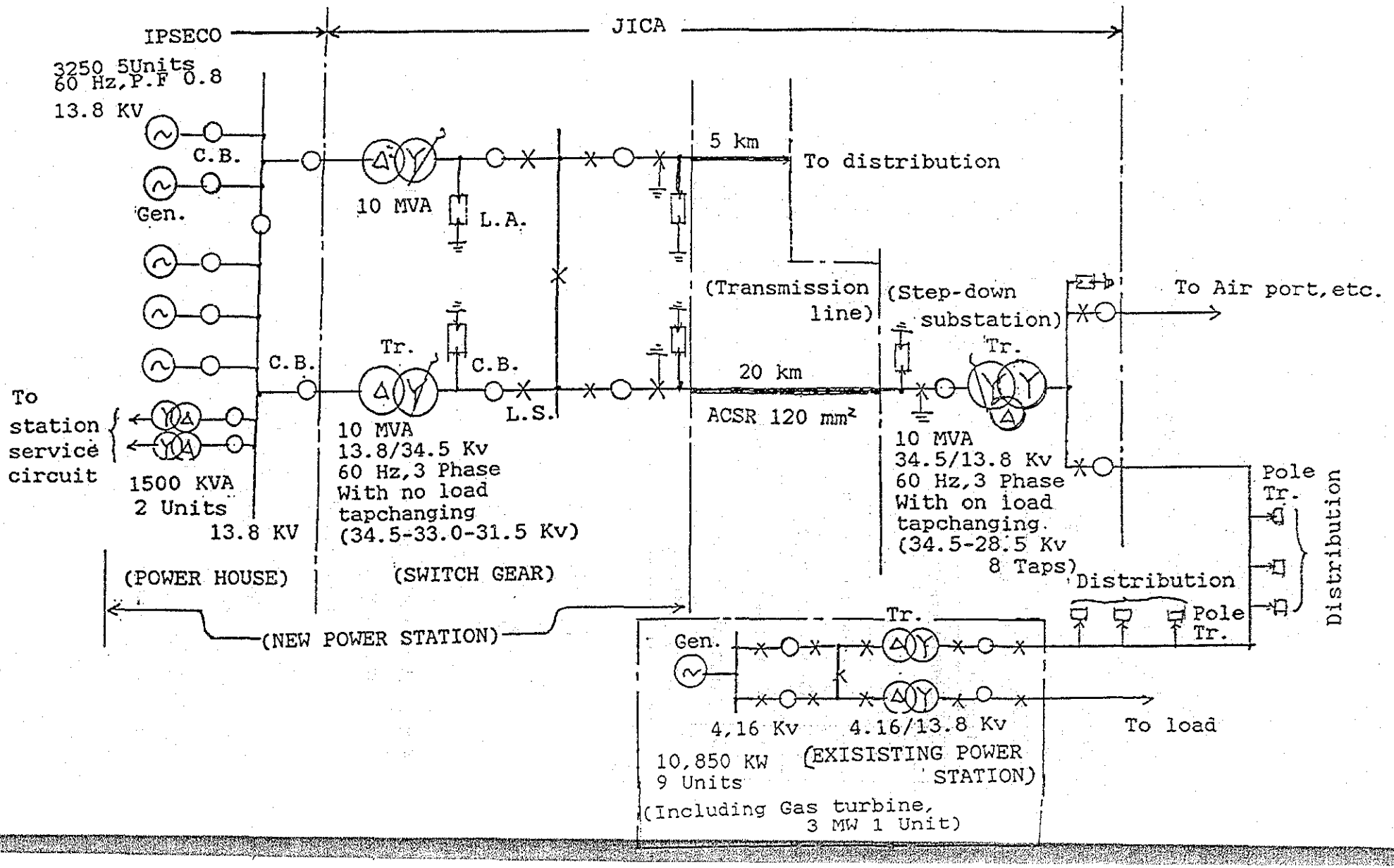
COMPARISON TABLE OF TRANSMISSION ROUTES

Items \ Route		A	B	C
(1)	Length (KM)	20	20	11
(2)	Construction cost (%)	130	100	not less than 500
(3)	Maintenance and repair	easy	easy	difficult
(4)	Construction work	easy	easy	difficult
(5)	Relation with electrification	2	1	3
(6)	Transmission loss	3	2	1
(7)	Total judgement	2	1	3

Note: Numerical order in items (5), (6) and (7) indicate order of priority.

POWER SYSTEM DIAGRAM

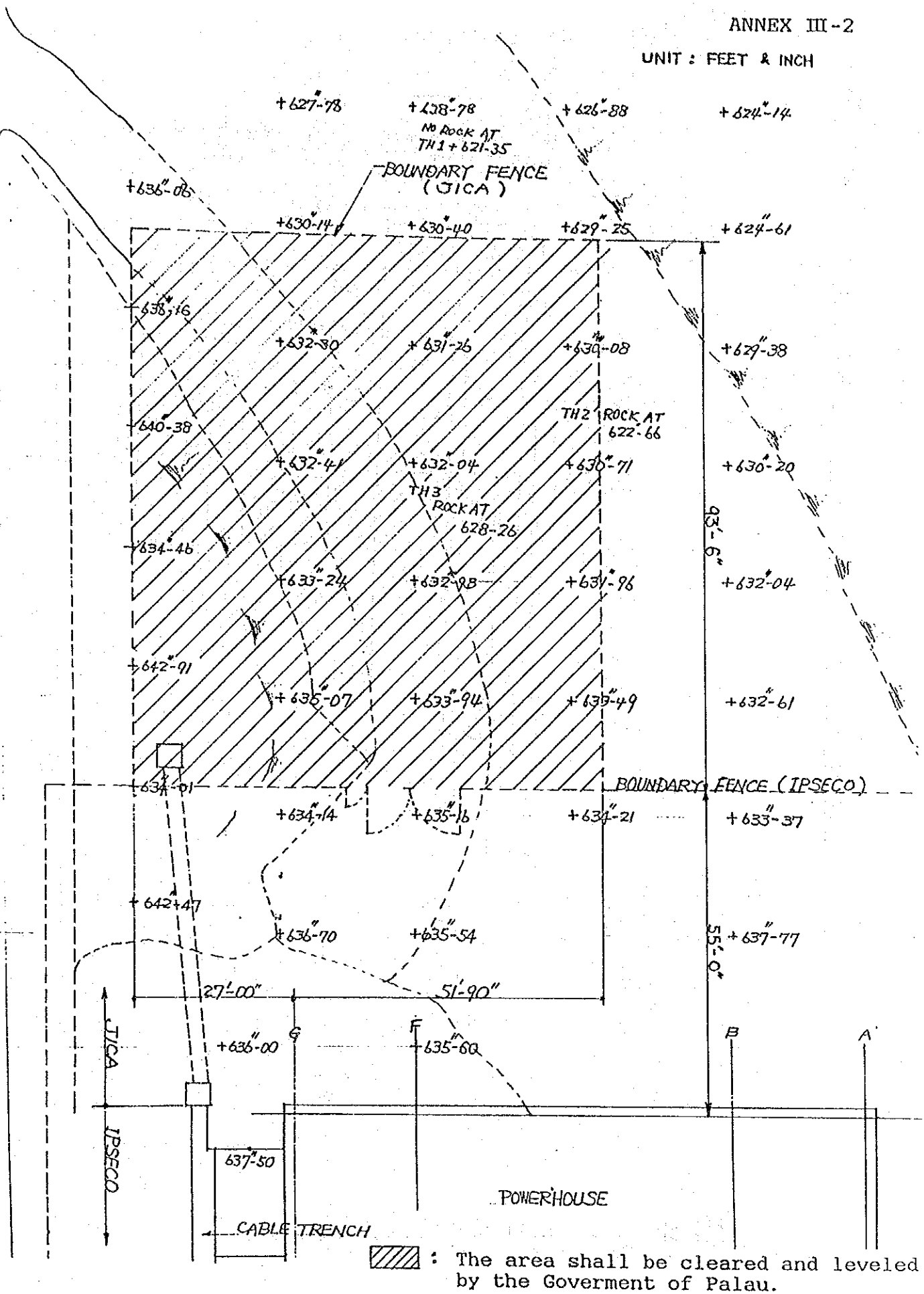
ANNEX III-1



STEPUP SUBSTATION LOCATION

ANNEX III-2

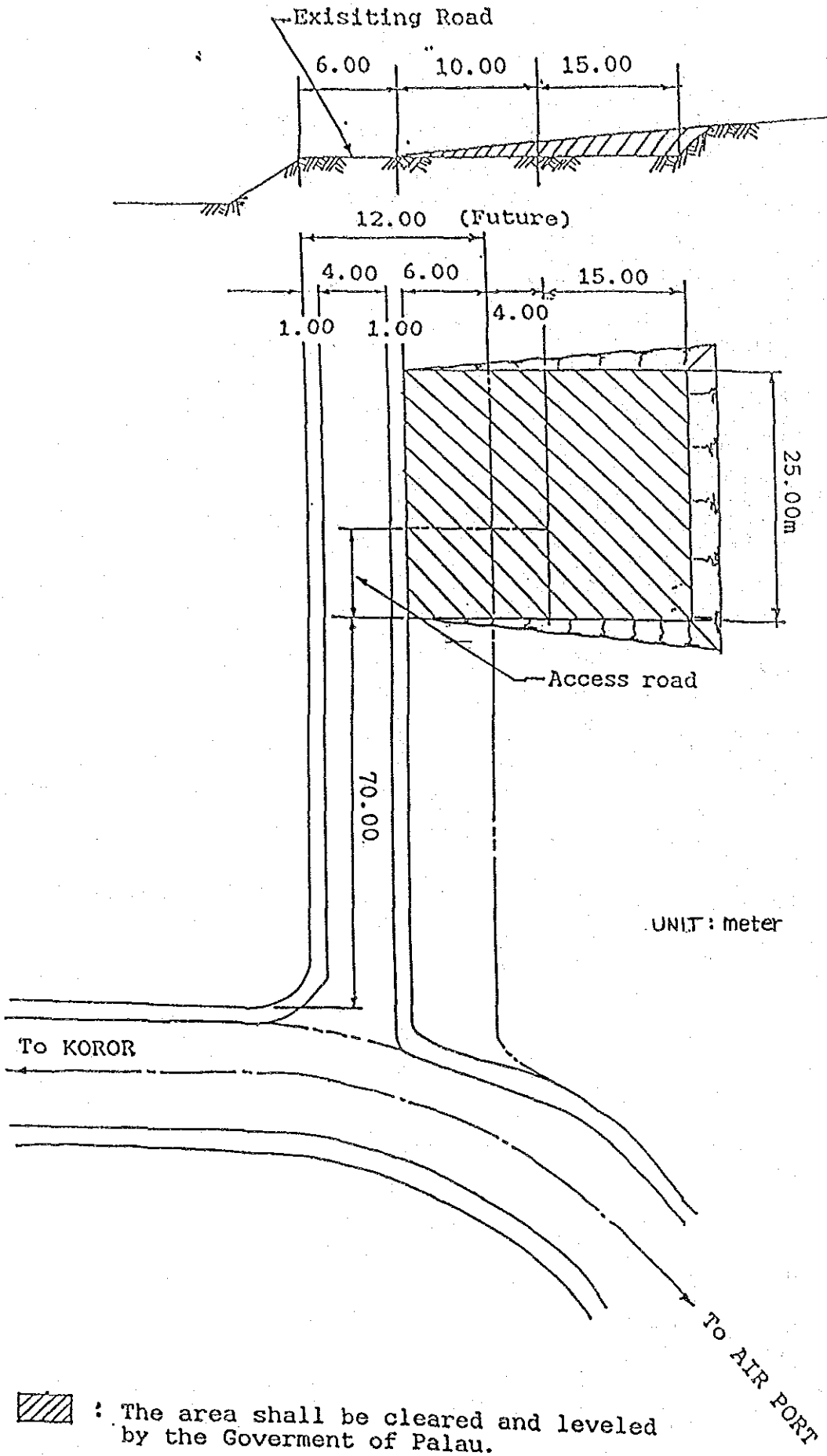
UNIT : FEET & INCH



: The area shall be cleared and leveled by the Goverment of Palau.

ANNEX III-3

STEPDOWN SUBSTATION LOCATION



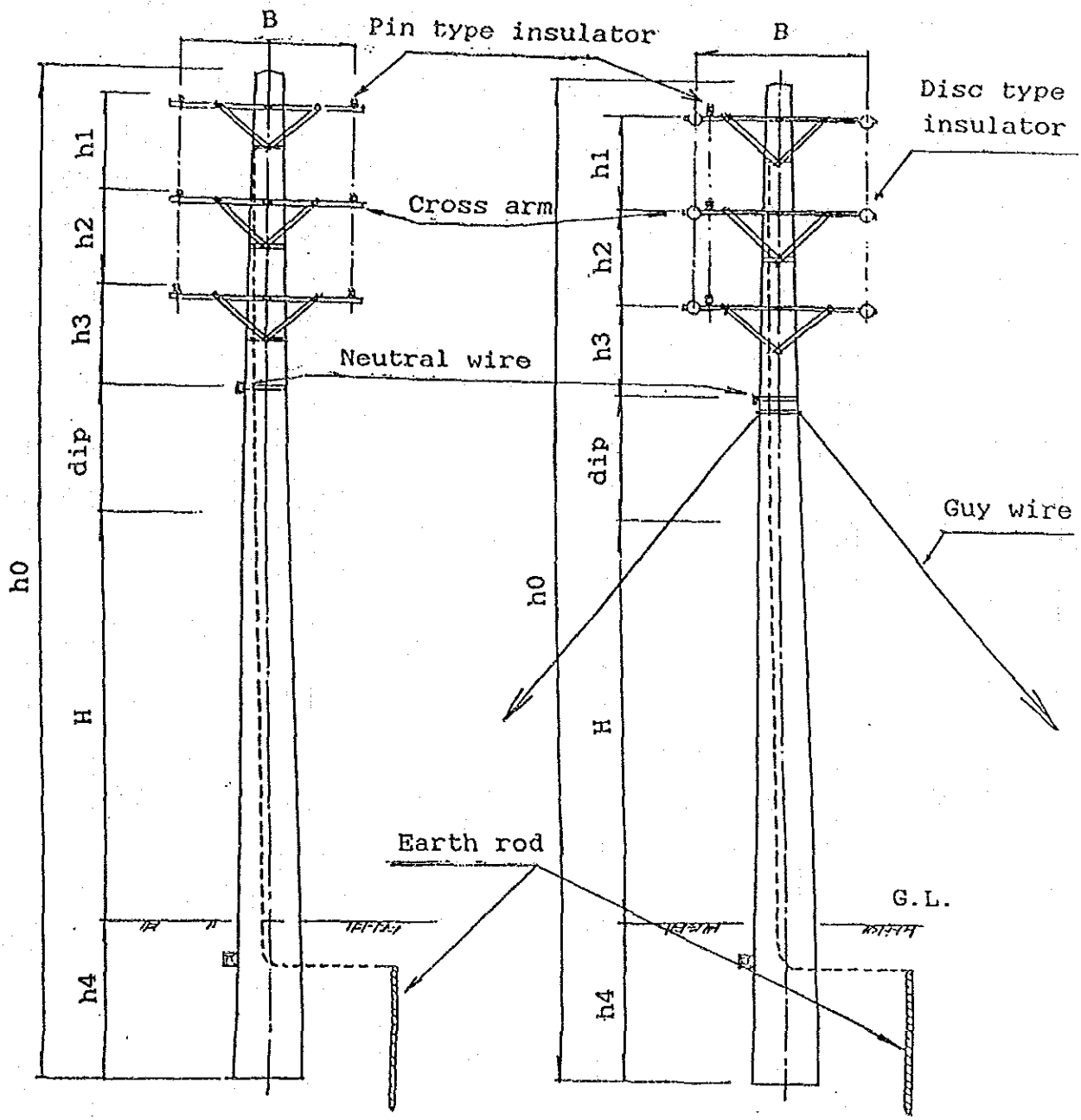
: The area shall be cleared and leveled by the Goverment of Palau.

34.5 KV TRANSMISSION LINE

(2 Ccts)

SUSPENSION POLE

SECTION POLE



NOTE: These types are applied to the transmission line from Imelsubech to Nekkeng.

34.5 KV TRANSMISSION LINE

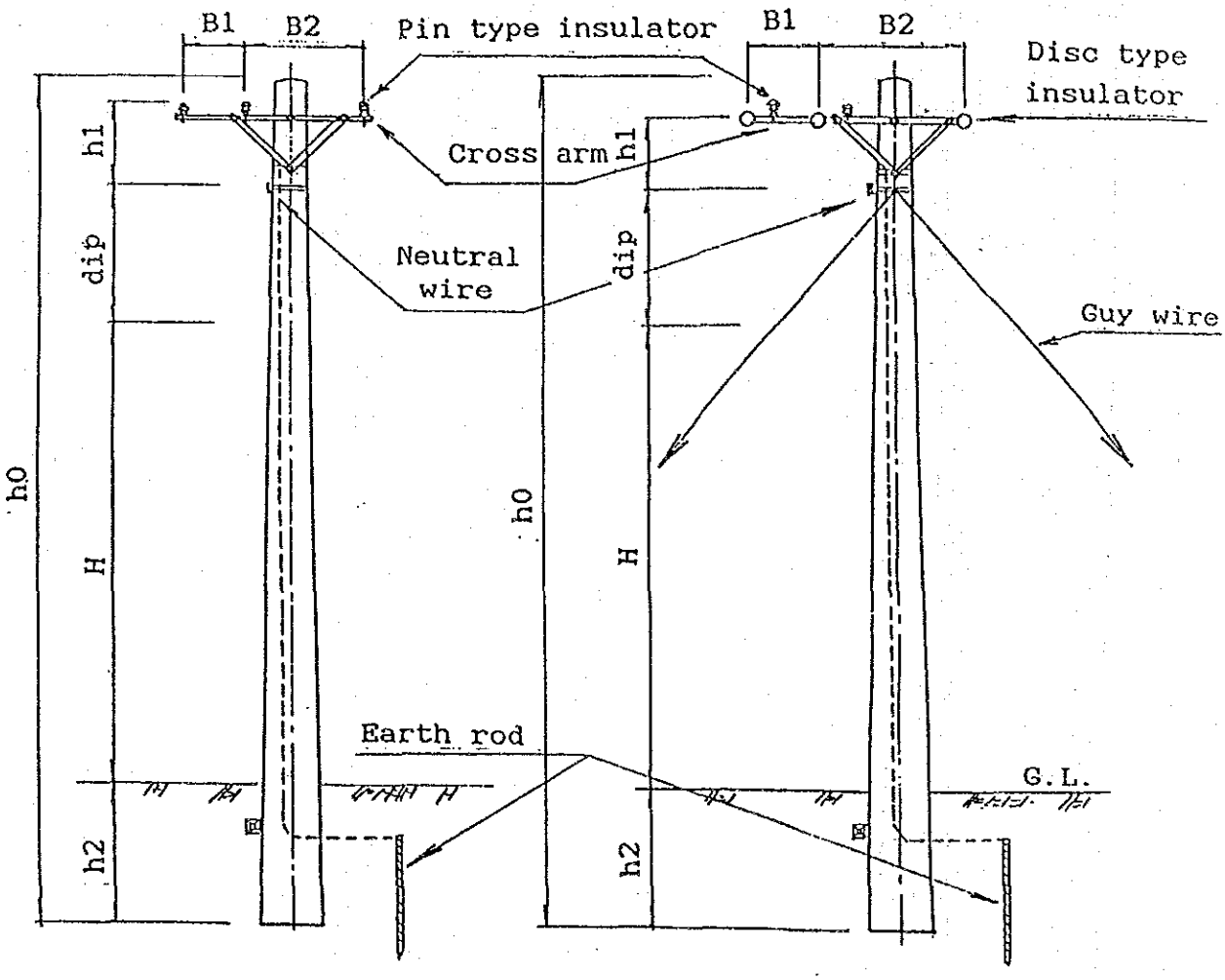
OR

13.8 KV DISTRIBUTION LINE

(1 Cct)

SUSPENSION POLE

SECTION POLE

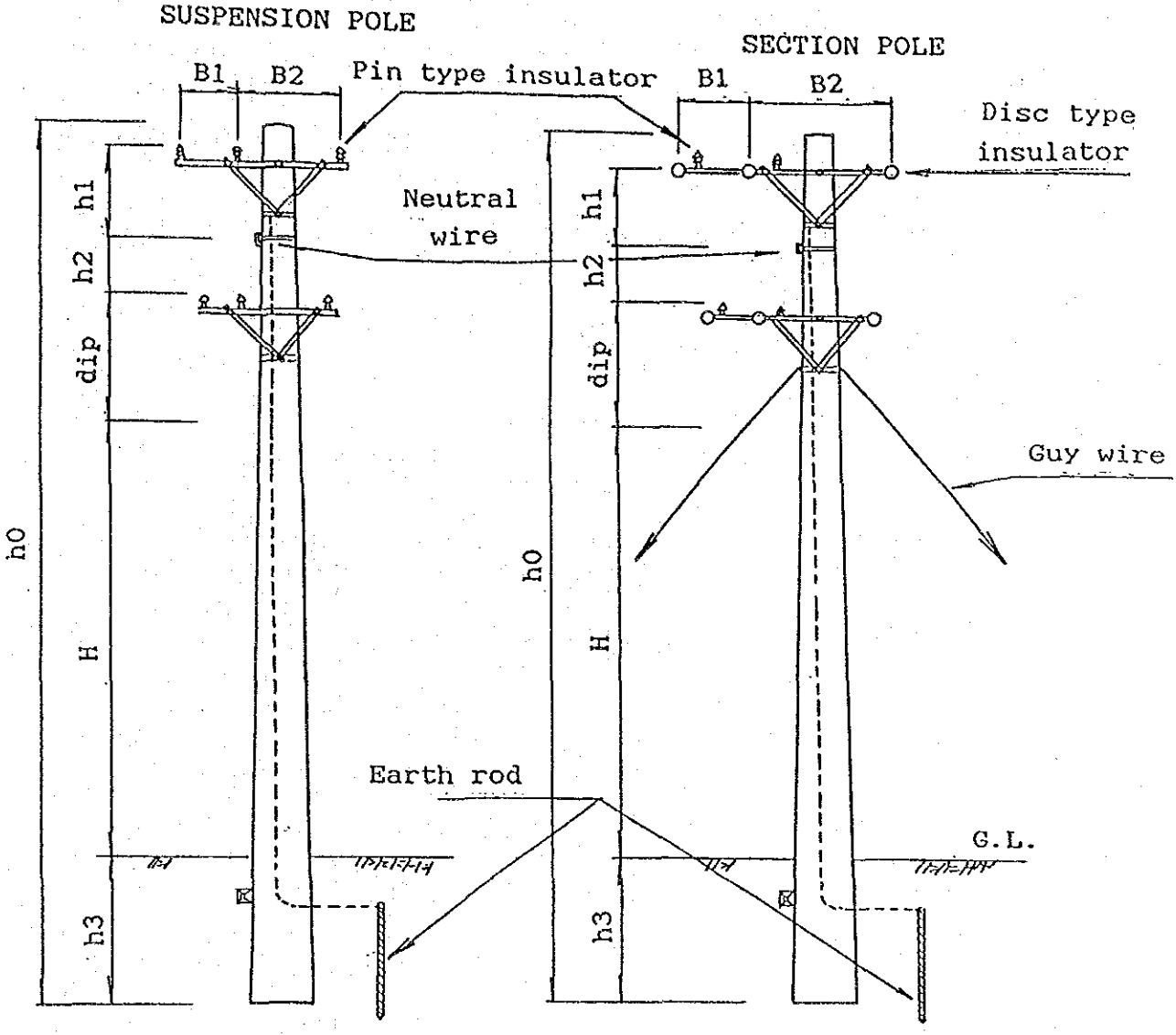


34.5 KV TRANSMISSION LINE

AND

13.8 KV DISTRIBUTION LINE

(2 Ccts)

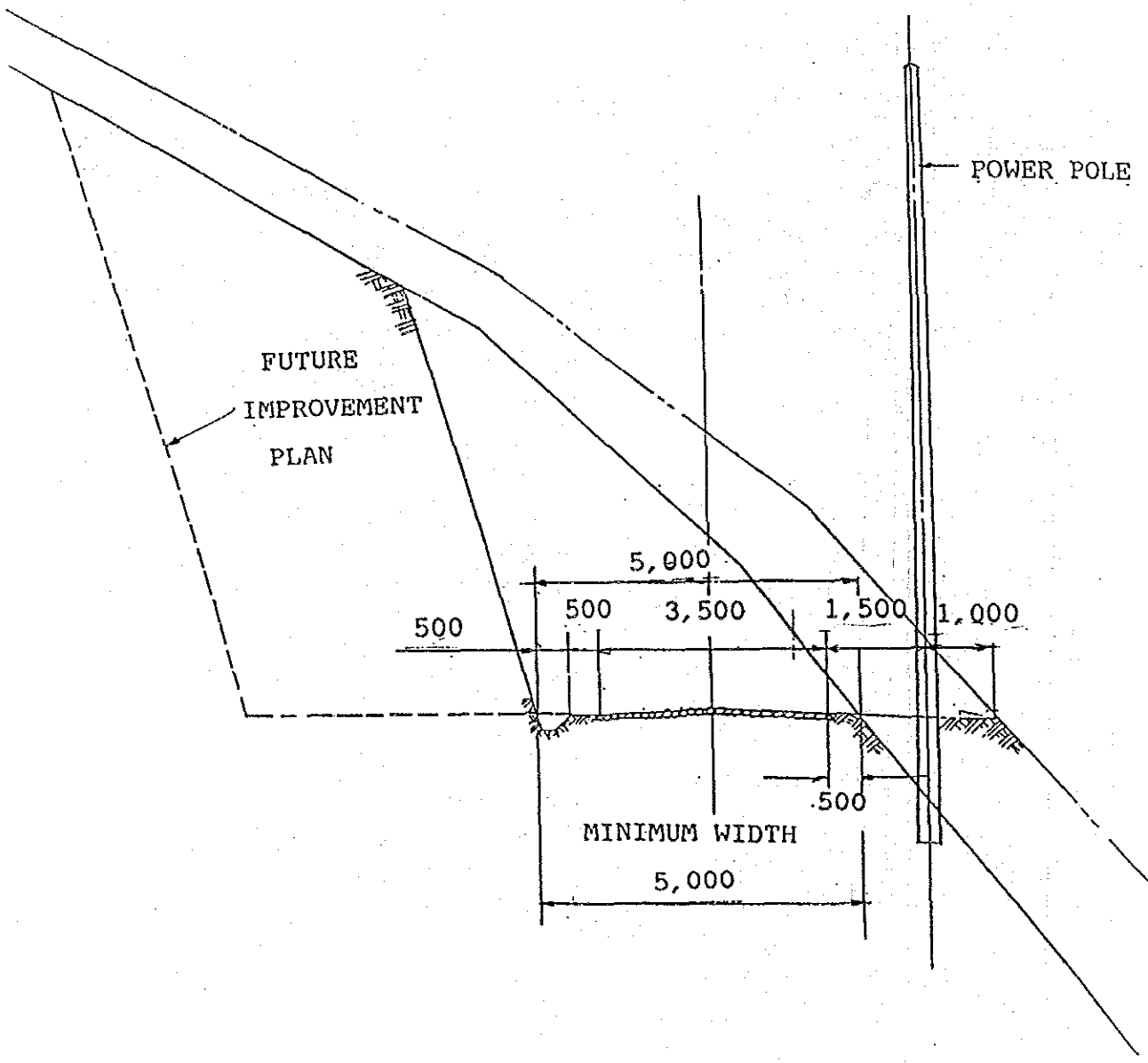


NOTE 1: It is possible to be mounted the transformer on the pole, if necessary.

NOTE 2: These types are applied to the "B" Route.

TYPICAL CROSS SECTION
ROAD ROUTE "B"

UNIT : millimeter



Annex V

PROJECT DESIGN CRITERIA

1. The drawing point between the power station and the project lies on the terminal board of the cubicle for the out-going feeder in the power station.

2. The main cable between CB for the out-going feeder and transformers for 13.8KV/34.5 KV and the control cables for AC 110V and DC 110V are design along the existing cable duct in the power station.

3. The control panel for switchboard is designed along with the main unit of control panel in the power station.

4. The CB's for transmission lines are designed to be automatically reclosed in case of a fault in the transmission line.

5. DC electric source is supplied by DC 30V in the power station. Since only DC 110V is adopted in the Japanese standard, DC 110V battery and changer are to be specifically designed to meet the need.

6. The earth wire in the switch yard is designed with meshed components and is connected to the earth of the power station, and the earth resistivity is designed within one ohm.

7. The Japanese standard is adopted for the entire design and procurement of machines based on S.I. Unit in their measurement.

8. The tranformer substations are to be designed to provide for catchment of spilled transformer oil, and proper fencing to protect people and animals from high voltages.

9. The control panel for the switch yard is to be compatible with that in the power station in size and color.

10. Additional space for tansformer to be used in conjunction with future additional generation capacity (beyond 16 megawatt) is not considered at this time; however, a bus arrangement is to be properly designed.

11. Wind velocity is 40 m/s as a 10-minute average, corresponding to a maximum wind velocity of 52 m/s.

12. Seismic intensity. Horizontal is 0.4G and vertical is 0.25G.

13. Temperature: 35 degrees C maximum ambient temperature.
    28 degrees C average ambient temperature.
    20 degrees C minimum ambient temperature.

14. Lightning: 37 days/year

15. Earth of neutral wire: Required at each pole.

16. ACSR inner creased conductor is recommended by JICA's Basic Design Study Team but Government of Palau recommends either bare copper conductor and/or all aluminum conductor (AAC) of proper sizes.

17. Clearance and height of the transmission and distribution line are to be based on REA rules and regulations in general.

18. Poles are to be located no less than 1.5 meters from the edge of the existing road in Route B, but should be at least 20 feet from the center line of the road at other areas in general.

19. Voltage drop in the transmission and distribution lines shall not be more than 10 percent.

20. Electric poles are to be prestressed concrete with galvanized steel rungs in general.

21. Cross arms and other hardwares are to be heavy galvanized steel.

22. Voltage fluctuation of service wire drops shall be within plus or minus 10 percent. Conforming to standard design.

Annex VI

UNDERTAKINGS OF THE GOVERNMENT OF PALAU

1. To secure the necessary real estates and right of ways for the project.

2. To clear and level the sites for the transformer substation.

3. To clear and improve the road along Route B ready for power transmission line construction.

4. Designate a place where a 24-hour watch can be maintained so that the alarm for transmission line fault can be received.

5. Exempt tax and provide for immediate custom clearance for commodities necessary for project implementation.

6. Accord Japanese nationals whose services may be required in connection with the supplying of products and services under the verified contract such facilities as may be necessary for their entry into the Republic of Palau and stay therein for the performance of the required work under the project.

7. To maintain and use properly and effectively the facilities constructed and equipment purchased under the Grant Aid.

8. To bear all the expenses other than those to be borne by the Grant Aid, that is to receive, transport, store and install only those equipment and materials necessary for the hook-up of individual facility and/or home, as distinguished from those responsibilities to be assumed by the Contractor of this project.

9. To coordinate with the inhabitants living in the project areas to ensure expediency of the project implementation.

10. To maintain the present pier at Aimeliik in good repair so that the Contractor can utilize same for the implementation of the project.

Appendix 3-1-(1) Monthly Temperature, Precipitation, Humidity (2-1)

KOROR (1983)

MONTH	TEMPERATURE (°C)				MONTHLY AVERAGE	PRECIPITATION		MEAN RELATIVE HUMIDITY	
	AVERAGE		EXTREME			TOTAL	DAYS	09:00 am	15:00 pm
	Max.	Min.	Max.	Min.	(°C)	(mm)	—	(%)	(%)
JANUARY	30.3	23.6	31.1	22.2	27.0	87	19	75	72
FEBRUARY	30.9	23.7	31.7	22.2	27.3	16	12	73	66
MARCH	31.1	24.1	31.7	22.8	27.6	43	10	72	66
APRIL	31.7	24.1	32.2	22.8	27.9	79	12	72	67
MAY	31.8	24.8	32.8	22.8	28.3	146	20	75	71
JUNE	31.2	24.2	32.8	22.2	27.7	469	27	81	77
JULY	30.3	24.2	32.8	22.2	27.3	538	26	82	81
AUGUST	31.1	24.5	32.8	22.8	27.8	456	25	80	77
SEPTEMBER	30.6	24.6	32.8	22.8	27.6	298	19	82	78
OCTOBER	31.2	24.3	32.8	22.8	27.8	361	24	80	78
NOVEMBER	31.3	24.7	32.8	23.3	28.0	290	27	79	79
DECEMBER	31.1	24.4	32.2	22.8	27.8	266	26	80	78
TOTAL									
AVERAGE	31.1	24.3	32.3	22.7	27.7	254	21	78	74

SOURCE: NATIONAL WEATHER SERVICE OFFICE, PALAU

Appendix 3-1-(2) Monthly Temperature, Precipitation, Humidity (2-2)

KOROR (1984)

MONTH	TEMPERATURE (°C)				MONTHLY AVERAGE	PRECIPITATION		MEAN RELATIVE HUMIDITY	
	AVERAGE		EXTREME			TOTAL	DAYS	09:00 am	15:00 pm
	Max.	Min.	Max.	Min.	(°C)	(mm)	—	(%)	(%)
JANUARY	30.8	23.7	32.2	22.8	27.3	472	28	81	79
FEBRUARY	30.6	23.7	31.7	22.8	27.2	275	25	82	77
MARCH	31.2	24.1	32.2	22.2	27.6	345	25	79	76
APRIL	31.3	24.6	32.2	22.8	27.9	184	24	78	73
MAY	31.8	24.5	32.0	22.8	28.2	276	27	78	75
JUNE	30.9	23.8	31.7	22.8	27.3	419	25	81	79
JULY	31.4	23.6	32.8	22.2	27.5	326	22	78	75
AUGUST	30.5	23.9	32.2	21.1	27.2	444	22	78	77
SEPTEMBER	31.1	24.1	32.8	22.2	27.6	264	21	76	75
OCTOBER	30.1	24.2	32.2	22.8	27.2	405	26	82	78
NOVEMBER					No Data				
DECEMBER					No Data				
TOTAL	—	—	—	—	—	—			
AVERAGE	31.0	24.0	32.3	22.5	27.5	341	24.5	79	76

SOURCE: NATIONAL WEATHER SERVICE OFFICE, PALAU

Appendix 3-1-(3)

Yearly and Monthly Average Temperature

KOROR
1978-1984

MONTH	AVERAGE TEMPERATURE (°F)						
	1978	1979	1980	1981	1982	1983	1984
JANUARY	81.3	81.4	80.8	81.1	81.7	80.5	81.1
FEBRUARY	80.1	81.3	80.2	80.4	81.7	81.2	80.9
MARCH	82.0	81.3	81.4	81.2	81.1	81.7	81.7
APRIL	81.9	81.3	81.8	82.0	81.7	82.2	82.3
MAY	82 6	81.4	82.5	82.6	81.8	83.0	82.7
JUNE	81.8	81.0	81.8	80.9	81.5	81.9	81.2
JULY	82.3	81.1	81.1	81.2	81.1	81.1	81.5
AUGUST	80.8	81.6	80.9	81.7	81.1	82.0	81.0
SEPTEMBER	80.9	82.1	81.6	81.6	82.4	82.0	81.7
OCTOBER	81.4	82.0	82.3	81.2	81.8	82.0	80.9
NOVEMBER	81.7	82.2	83.0	82.5	82.3	82.4	—
DECEMBER	81.8	81.5	82.3	82.1	81.7	82.0	—
TOTAL							
AVERAGE	81.6	81.6	81.7	81.5	81.7	81.8	—

Yearly and Monthly Precipitation

KOROR
1978-1984

MONTH	PRECIPITATION (INCH)						
	1978	1979	1980	1981	1982	1983	1984
JANUARY	10.34	6.98	8.72	11.32	5.79	3.44	18.57
FEBRUARY	22.46	6.47	16.01	15.00	6.81	.64	10.81
MARCH	6.02	7.96	5.53	4.49	9.90	1.71	13.58
APRIL	8.98	27.69	18.80	3.00	9.45	3.12	7.23
MAY	12.52	11.26	10.02	9.66	19.12	5.73	10.85
JUNE	16.04	22.84	19.50	29.17	22.41	18.48	16.49
JULY	9.13	17.79	12.40	21.14	19.40	21.20	12.82
AUGUST	20.36	11.69	15.26	6.89	10.94	17.96	17.47
SEPTEMBER	10.85	12.29	13.60	16.70	1.04	11.73	10.39
OCTOBER	20.06	11.97	17.11	14.30	8.82	14.23	15.94
NOVEMBER	17.66	11.57	12.17	11.37	9.92	11.40	—
DECEMBER	10.33	11.57	19.95	9.81	13.71	10.48	—
TOTAL	164.75	160.08	169.07	132.83	137.31	120.12	
AVERAGE	13.73	13.34	14.09	12.74	11.44	10.01	—

SOURCE; NATIONAL WEATHER SERVICE OFFICE, PALAU

Appendix 3-1-(4)

Max. and Min. Precipitation

(Unit : mm)

Items / Month	Monthly Precipitation		Monthly Precipitation		Daily Precipitation	
	Max.	Year	Min.	Year	Max.	Year
January	714	1974	54	1973	352	1974
February	570	1978	31	1973	214	1980
March	558	1972	62	1955	157	1953
April	703	1979	42	1948	431	1979
May	697	1954	206	1974	209	1958
June	580	1979	150	1976	148	1972
July	884	1962	105	1964	209	1962
August	626	1952	210	1975	208	1962
September	528	1962	171	1967	215	1949
October	571	1974	172	1951	157	1957
November	560	1958	119	1957	131	1967
December	536	1975	161	1969	164	1974

——— Shows Max. (Min) Value for Past 10 Years.

Max. Wind Speed

Items / Month	Max. for Past 10 Years		
	Speed m/s	Direation	Year
January	19.1	NW	1975
February	13.3	SE	1968
March	32.4	S	1967
April	26.7	SW	1976
May	15.5	SW	1976
June	17.8	SW	1967
July	15.1	W	1969
August	15.1	SW	1978
Sepember	15.1	N	1969
October	16.0	SW	1968
November	26.2	SE	1964
December	22.2	N	1972

——— Shows Max.(Min) Value for Past 10 Years.

Source : National Wether Service Office, Palau

MAP UNITS

SOILS ON BOTTOM LANDS

1 — Dechel-Mesei-Ngersuul: Very deep, very poorly drained, and somewhat poorly drained, level and nearly level soils; on valley and coastal bottom lands

2 — Ngerungor Variant-Ngerungor: Very deep, very poorly drained, level and nearly level soils; on bottom lands and in depressional areas

3 — Ilachetomel: Very deep, very poorly drained, level soils; in the intertidal zone adjacent to the shoreline

SOILS ON MARINE TERRACES

4 — Tebecheding-Ngatpang: Very deep, somewhat poorly drained and moderately well drained, nearly level to steep soils; on dissected terraces

SOILS ON VOLCANIC UPLANDS

5 — Aimeliik-Palau: Very deep, well drained, nearly level to very steep; on hills

6 — Babelthuap-Aimeliik-Ngardmau: Very deep, well drained, nearly level to very steep soils; on hills and ridges

7 — Ngardok-Babelthaup: Very deep, well drained, nearly level to very steep soils; on ridgetops and side slopes

8 — Ollei-Nekken-Rock outcrop: Shallow and moderately deep, well drained, strongly sloping to very steep soils, and Rock outcrop; on hills and ridgetops

SOILS ON LIMESTONE

9 — Rock outcrop-Peleliu: Rock outcrop, and shallow, well drained, very steep soils; on uplands

10 — Peleliu-Rock outcrop: Shallow, well drained, nearly level to moderately steep soils, and Rock outcrop; on low-lying coral islands

SOILS THAT FORMED IN CORAL SAND

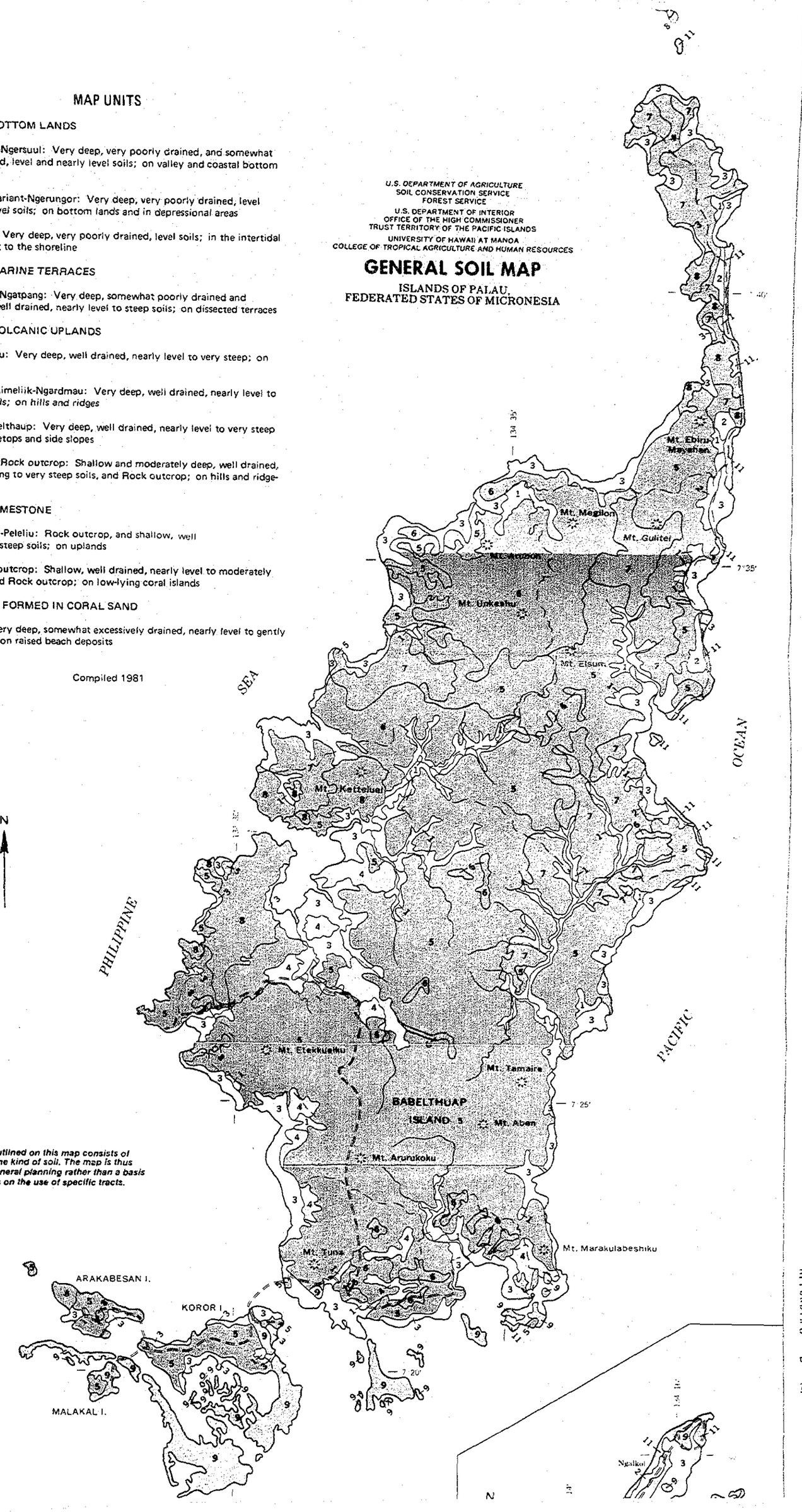
11 — Ngedebus: Very deep, somewhat excessively drained, nearly level to gently sloping soils; on raised beach deposits

Compiled 1981

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FOREST SERVICE
U.S. DEPARTMENT OF INTERIOR
OFFICE OF THE HIGH COMMISSIONER
TRUST TERRITORY OF THE PACIFIC ISLANDS
UNIVERSITY OF HAWAII AT MANOA
COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES

GENERAL SOIL MAP

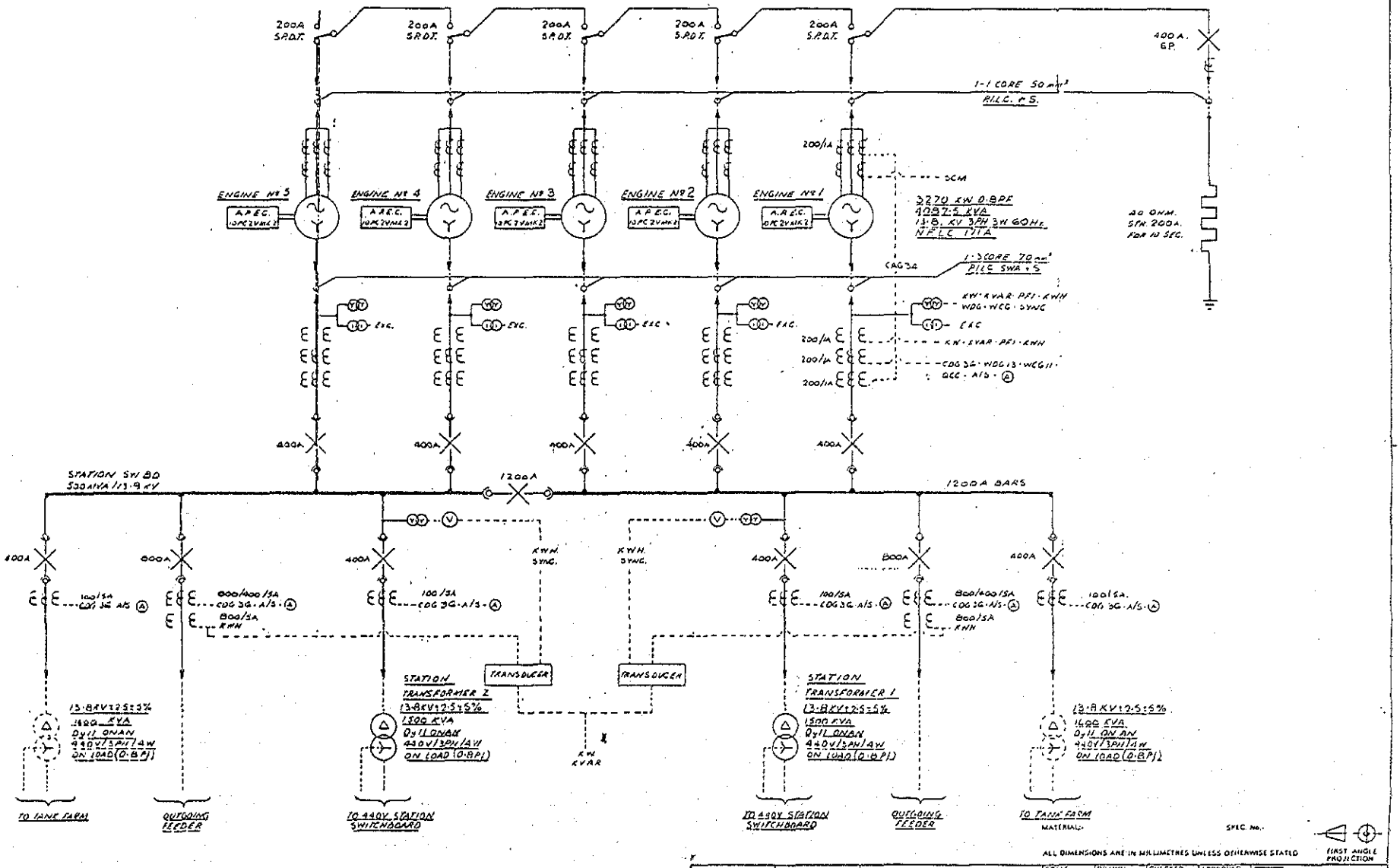
ISLANDS OF PALAU
FEDERATED STATES OF MICRONESIA



Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

Appendix 3-2-(2) Grading Analysis and Physical, Chemical Properties

SOIL NAME AND MAP SYMBOL	SAMPLING DEPTH	CLASSIFICATION	FRAG-MENTS	PERCENTAGE PASSING SIEVE NUMBER				PERMEABILITY	pH	LIQUID LIMIT
			>76mm	4 (5mm)	10 (1.5mm)	40 (0.5mm)	200 (0.074mm)			
	(cm)		(%)	(%)	(%)	(%)	(%)	(cm/hr)		(%)
⑤ Aimeliik	0 – 10	Silt loam	0	85-100	85-100	75-100	60-90	5 -15	3.6-5.0	80-90
	10 – 86	Silt loam, Silty clay clay	0	95-100	90-100	85-100	75-90	5 -15	4.5-5.5	75-85
	86-150	Silt loam, Silty clay loam	0	100	100	90-100	80-95	5 -15	4.5-5.5	75-85
⑤ Babelthuap	0 – 10	Very gravelly loam	0-15	80-90	20-50	20-50	15-40	15 -50	3.6-5.5	35-60
	10 – 64	Silty clay loam, Silty clay	0	95-100	75-90	70-90	65-85	5 -15	3.6-5.5	65-85
	64-150	Silty loam, Silty clay loam	0	95-100	75-90	70-85	65-85	5 -15	4.5-5.5	80-95
⑧ Nakken	0 – 20	Very gravelly silt loam	10-20	30-55	25-50	25-45	20-35	5 -15	5.6-6.5	25-35
	20 – 46	Very gravelly clay loam	10-20	30-55	25-50	25-50	20-45	1.5 – 5	5.1-6.0	35-45
	46-56	Very gravelly silt loam	10-20	40-60	35-55	30-50	25-40	1.5 – 5	5.1-6.0	25-35
	56-150	Unweatherd bedrock	—	—	—	—	—	—	—	—
⑤ Ngatpang	0 – 15	Silty clay loam	0	80-100	75-100	70-100	65-95	1.5 – 5	4.5-5.5	80-90
	15 – 28	Gravelly silty clay Gravelly clay loam Very gravelly clay loam	0	45-80	35-75	30-75	25-70	1.5 – 5	3.6-5.0	75-85
	28-114	Clay, silty clay	0	95-100	90-100	80-100	70-95	0.5 – 1.5	3.6-5.0	75-85
	114-150	Clay, silty clay	0	100	100	90-100	75-95	0.2<	3.6-5.0	80-100
① Dechel 408	0 – 10	Mueky silt loam	0	100	100	90-100	70-100	5 -15	5.1-7.3	75-100
	10-102	Silty clay loam	0	100	100	90-100	85-100	0.5 – 1.5	5.1-7.3	65-75
	102-109	Very gravelly silty clay loam	10-15	35-60	30-55	30-55	25-55	1.5 – 5.0	5.1-7.3	65-75
	109-168	Silty clay loam, Silty loam	0	100	100	90-100	85-100	0.2 – 0.6	5.1-7.3	65-75
③ Llachetomel	0-150	Peat	—	—	—	—	—	15 -50	5.6-6.0	—
④ Tabecheding	0 – 18	Silty clay loam	0	100	100	95-100	90-95	1.5 – 5.0	3.6-5.0	50-60
	18 – 51	Clay, Silty clay	0	80-100	75-100	70-100	60-95	0.2 – 0.5	3.6-4.4	80-100
	51-158	Clay, Silty clay	0	80-100	75-100	70-100	60-95	<0.2	3.6-4.4	90-115

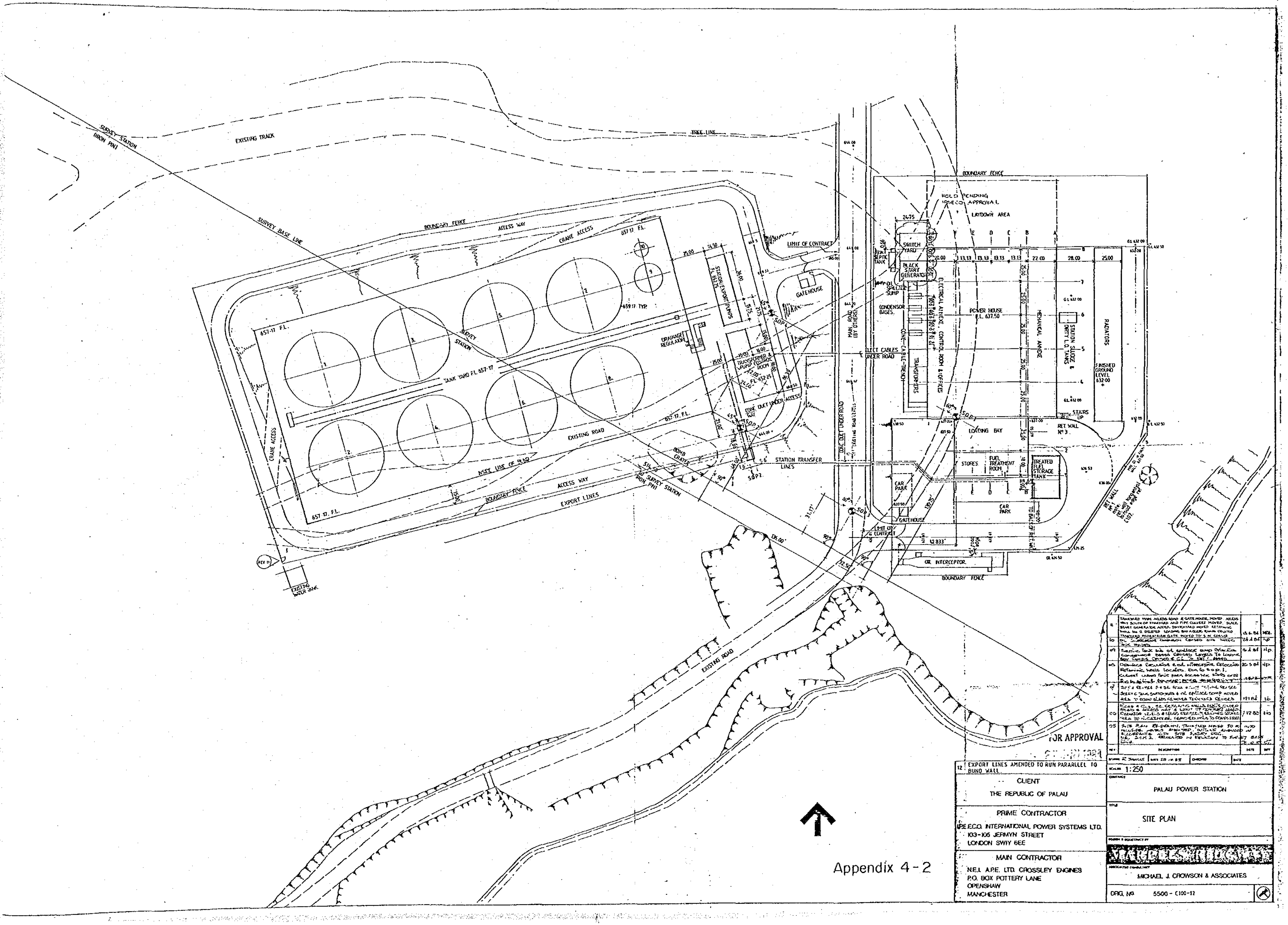


Appendix 4 - 1

REV B 11-10-83	REV A 28-9-83	PRIME CONTRACTOR: IPSECO, INTERNATIONAL POWER SYSTEMS LTD 85-87 JERMYN STREET, LONDON SW1Y 6JD.	SCALE	DRAWN G.PAPSEN 22-3-83	CHECKED	APPROVED	Crossley Engines
			TITLE 13.8KV POWER DISTRIBUTION / EARTHING SCHEME. PALAU 5 x 3.27 MW POWER STATION CONTRACT No.				DRAWING NUMBER SC 8353

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED

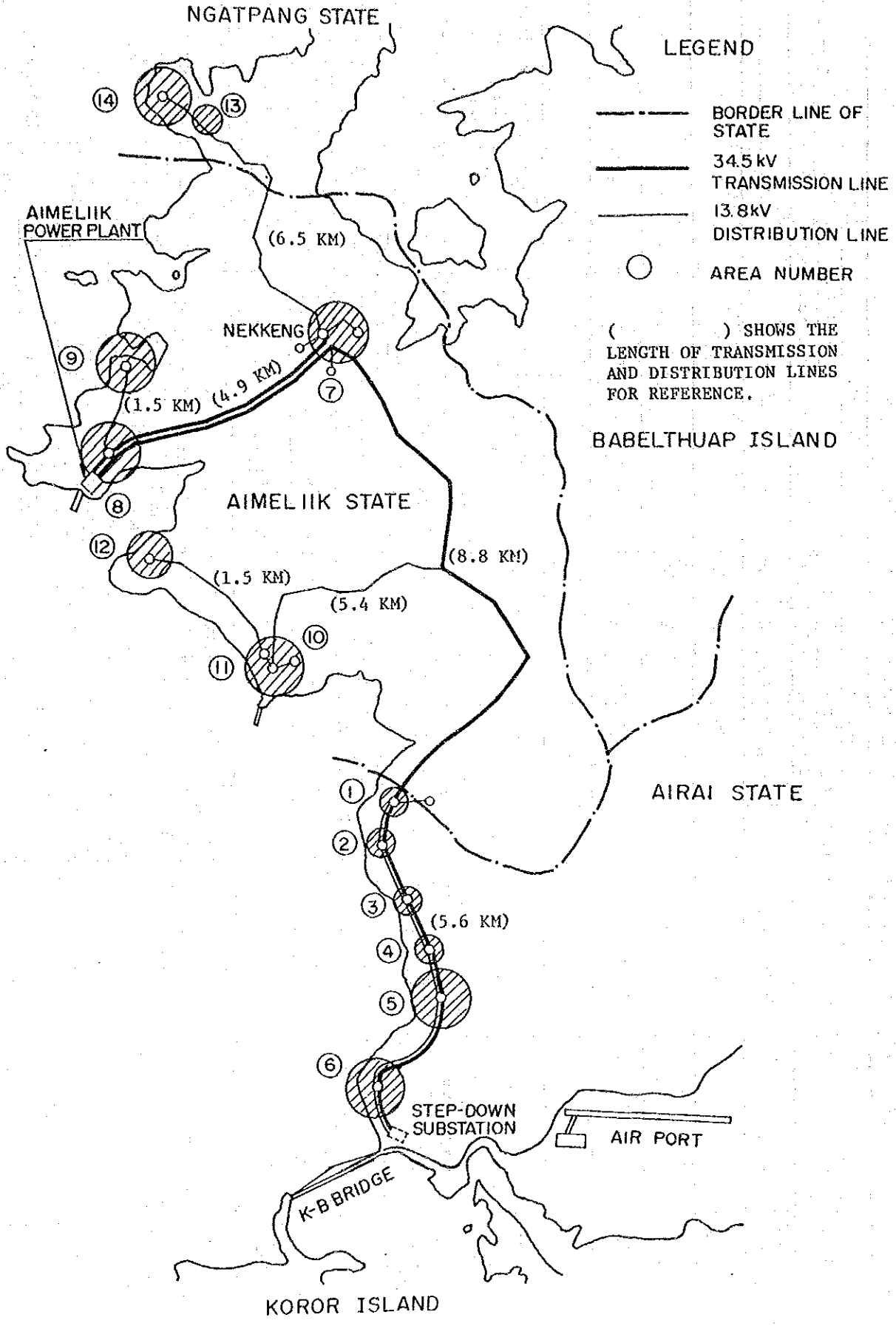
FIRST ANGLE PROJECTION



SURVEY STATION (IRON PIN)
EXISTING TRACK
TREE LINE
SURVEY BASE LINE
BOUNDARY FENCE
ACCESS WAY
CRANE ACCESS
657.17 F.L.
659.17 TYP.
TANK YARD FL 657.17
EXISTING ROAD
INSIDE LINE OF BUND
EXPORT LINES
DRAINAGE REGULATOR
STATION EXPORT PUMPS
TRANSFORMER & PUMP CONTROL ROOM
CONC. DUCT UNDER ACCESS
BOMB CRATER
STATION TRANSFER LINES
EXISTING WATER TANK
LIMIT OF CONTRACT
GATEHOUSE
MAIN ROAD (BY OTHERS)
ELECT CABLES UNDER ROAD
CONC. DUCT UNDER ROAD
HOLD PENDING IRSECO APPROVAL
LAYDOWN AREA
BOUNDARY FENCE
SWITCH YARD
SEPTIC TANK
BLACK START GENERATOR
OIL SEPARATOR SUMP
CONDENSOR BASES
CONC. CABLE TRENCH
TRANSFORMERS
ELECTRICAL ANNEXE, CONTROL ROOM & OFFICES
POWER HOUSE F.L. 637.50
MECHANICAL ANNEXE
STATION SLUDGE & DIRTY L.O. TANKS
RADIATORS
FINISHED GROUND LEVEL 632.00
STAIRS UP
LOADING BAY
RET WALL Nº 3
STORES
FUEL TREATMENT ROOM
TREATED FUEL STORAGE TANK
CAR PARK
OIL INTERCEPTOR
FOR APPROVAL
12 EXPORT LINES AMENDED TO RUN PARARLLEL TO BUND WALL.
CLIENT
THE REPUBLIC OF PALAU
PRIME CONTRACTOR
I.P.E.E.C.O. INTERNATIONAL POWER SYSTEMS LTD.
103-105 JERMYN STREET
LONDON SW1Y 6EE
MAIN CONTRACTOR
N.E.I. A.P.E. LTD. CROSSLEY ENGINES
P.O. BOX POTTERY LANE
OPENSHAW
MANCHESTER
SCALE 1:250
PALAU POWER STATION
SITE PLAN
MICHAEL J. CROWSON & ASSOCIATES
DRG. Nº 5500 - C100-12

Appendix 4-2

Appendix 5-1-(1) ELECTRIFICATION AREA MAP



Appendix 5-1-(2) Detail of Electrification Plan (1)

No	State	Area	Houses						Others				Total kVA	Remarks
			Existing		Future		Total		Items	kVA				
			No.	kVA	No.	kVA	No	kVA		Exsit.	Future	Total		
①	Airai	Zone 1	—	—	10	13	10	13					13	
②	〃	〃 2	—	—	5	6	5	6					6	
③	〃	〃 3	—	—	10	13	10	13					13	
④		〃 4	—	—	10	13	10	13					13	
⑤	〃	〃 5	1	1	2	3	3	4					4	
⑥	〃	〃 6	2	3	—	—	2	3					3	Seven (7) houses already receive the power of Airai State.
⑦	Aimeliik	NEKKENG	3	4	—	—	3	4	Forestry Stn.	12.5	—	12.5		
									OISCA	12.5	—	12.5		
												25	29	
⑧	〃	Imelsubech	11	14	—	—	11	14	IPSECO	13	—	13	27	
⑨	〃	Medorm	13	16	—	—	13	16	Communi. Center	4	—	4	20	
⑩	〃	Imul	24	30	—	—	24	30					30	
⑪	〃	Ngeikeai	8	10	—	—	8	10	Goverment. Office	6		6		
									Elementary School	4		4		
									Kindergarten	4		4		
									Billiards	1		1		
									Repair Shop	4		4		
									Ice Plant	24		24		220V, 3ø
												43	53	

Appendix 5-1-(2) Detail of Electrification Plan (2)

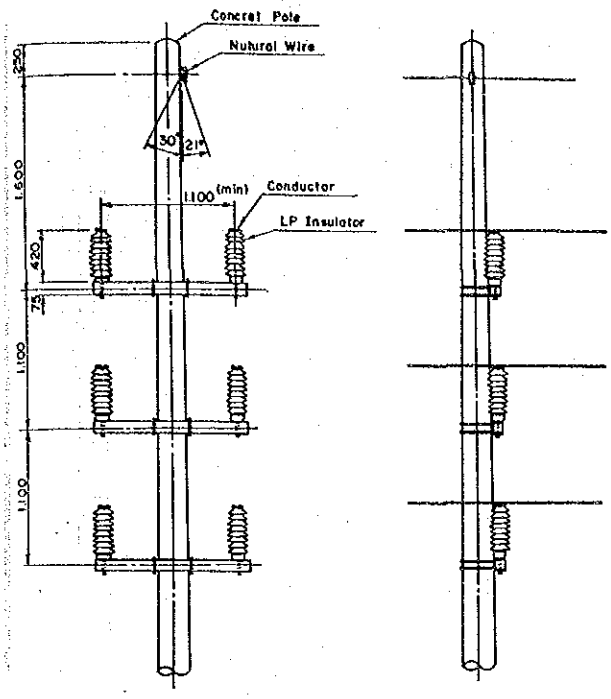
No.	State	Area	Houses						Others				Total	Remarks
			Existing		Future		Total		Items	kVA				
			No.	kVA	No.	kVA	No.	kVA		Exsit.	Future	Total		
⑫	Aimeliik	Elechui	5	6	—	—	5	6	Communi. Center	4	—	4	10	Becanse rood condition is very bod , Construction of distribution line is very difficult.
⑬	Ngatpang	Housing area	—	—	30	38	30	38					38	
⑭	〃	Ngatpang	11	14			11	14	Goverment Office	6	—	6		
									Communi. Center	6	—	6		
									Meeting Place	3	—	3		
									Elementary School	4	—	4		
									Pier	0.5	—	0.5		
									Ice Plant	24	—	24		220V, 3ø
									Dock House	0.5	—	0.5		
									Public Works	—	6	6		
												50	64	
Total			78	98	67	86	145	184				139	323	

Appendix 6 - 1 Measurement of Salt Contamination

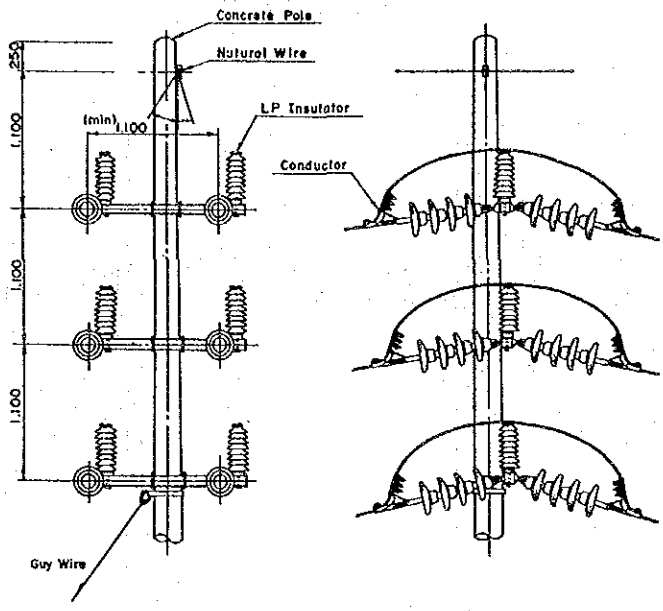
Test No.	Kind of Insulator	Dia. x Height (mm)	Insulation Mark	Insulation Color	Exposed Term	Surface of Measurement	Salt Contamination
1 - 1	Pin Type	135ø x 110	1973 ME	Gray	1/17 ~ 1/19 (3 days)	All	Less Than 0.01%
1 - 2	〃	〃	〃	〃	1/20 ~ 1/25 (6 days)	〃	〃
2	〃	〃	〃	〃	1/17 ~ 1/25 (9 days)	〃	〃
3	〃	〃	〃	〃	〃	〃	〃
4	〃	〃	1970 ME	Brown	More Than 10 Years	〃	〃
5	High - Voltage Pin Type	168ø x 145	CHANCE' 1968	〃	1/17 ~ 1/25 (9 days)	〃	〃
6	Dead End Type	155ø x 128	LOCKE 1951EU	〃	More Than 10 Years	Under	〃
						Under + Upper	〃
7	〃	〃	〃	〃	〃	〃	〃
						〃	〃
8 - 1	Suspension	254 x 140	(Nichigai) 1950-10	Gray	1/17 ~ 1/19 (3 days)	〃	〃
						〃	〃
8 - 2	〃	〃	〃	〃	1/20 ~ 1/25 (6 days)	〃	〃
						〃	〃
9	〃	〃	〃	〃	1/17 ~ 1/25 (9 days)	〃	〃
						〃	〃
10	〃	〃	〃	Brown	〃	〃	〃
						〃	〃
11	〃	〃	〃	〃	〃	〃	〃
						〃	〃

※ Salt Contamination ; Measured it by washing surface of the insulator with 150 ml - water.

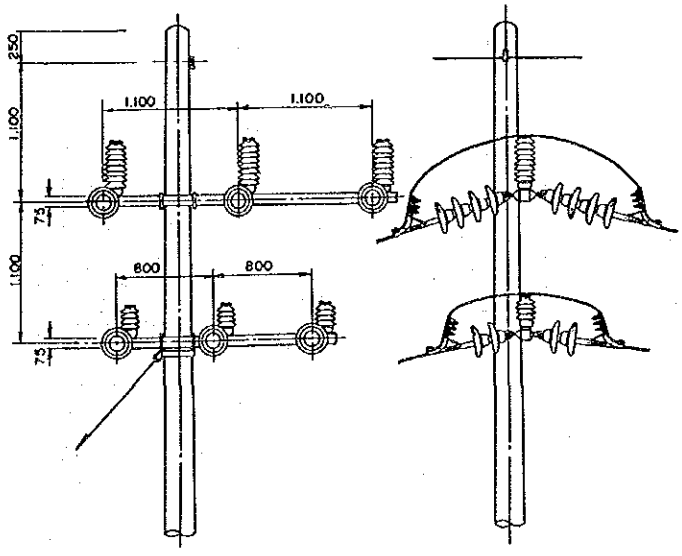
Appendix 6 - 2 - (1) Example of Support Structure Arrangement



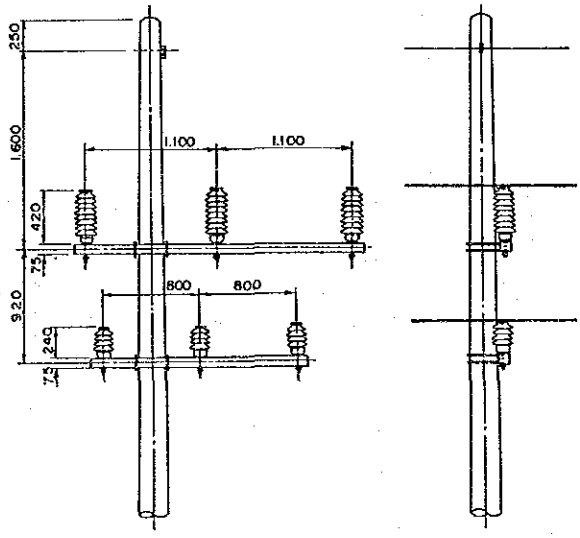
Suspention Pole 34.5kV 2cct



Section Pole 34.5kV 2cct

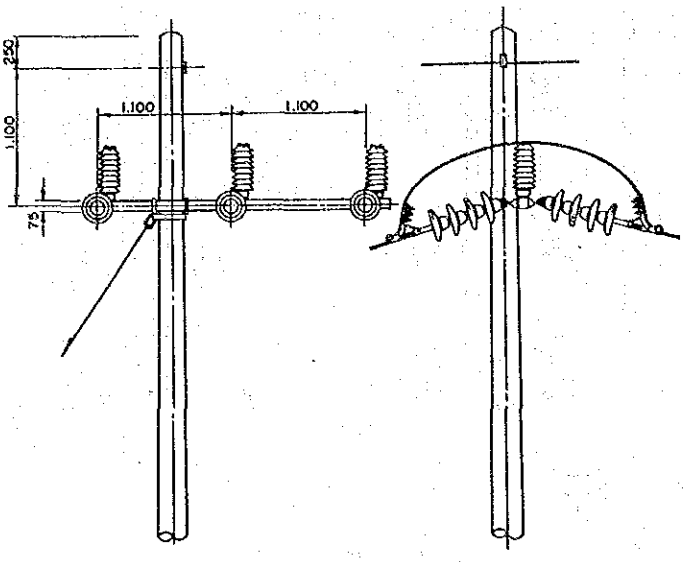


Section Pole 34.5 kV 1cct
13.8 kV 1cct

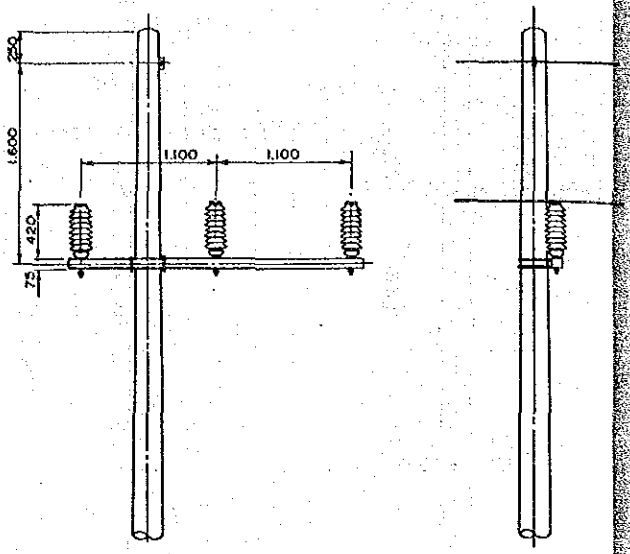


Suspention Pole 34.5 kV 1cct
13.8 kV 1cct

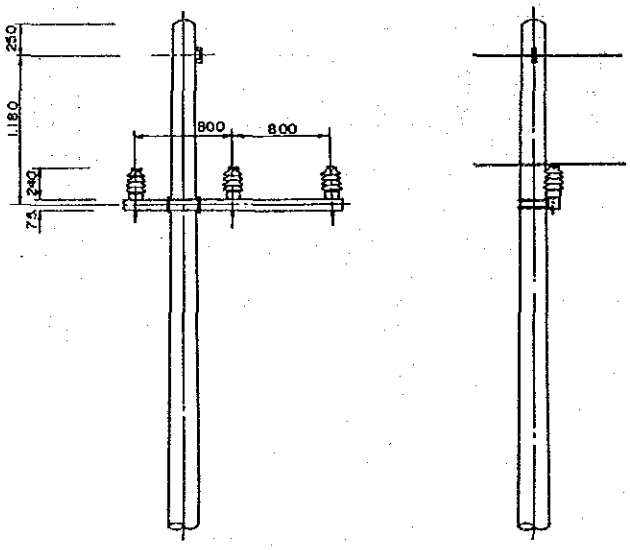
Appendix 6 - 2 - (2) Example of Support Structure Arrangement



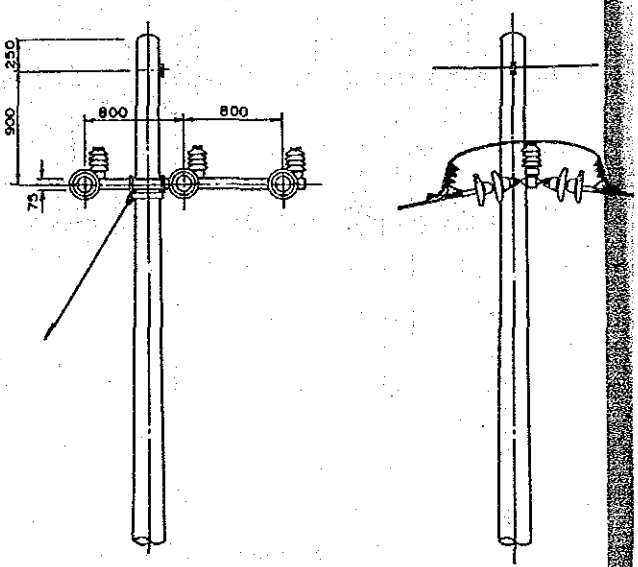
Section Pole 34.5kV 1cct



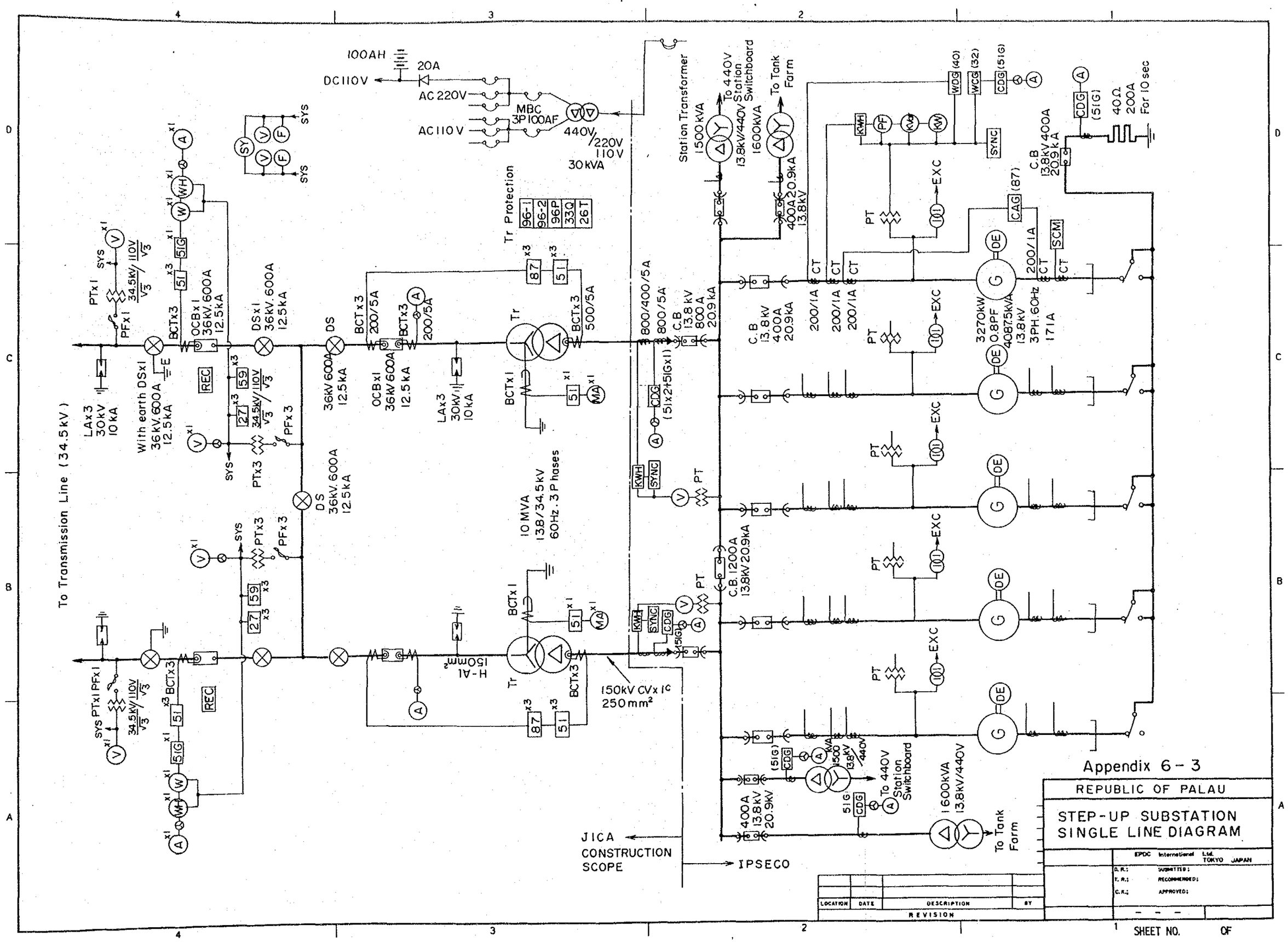
Suspention Pole 34.5kV 1cct



Suspention Pole 13.8kV 1cct



Section Pole 13.8kV 1cct



Appendix 6 – 3

REPUBLIC OF PALAU

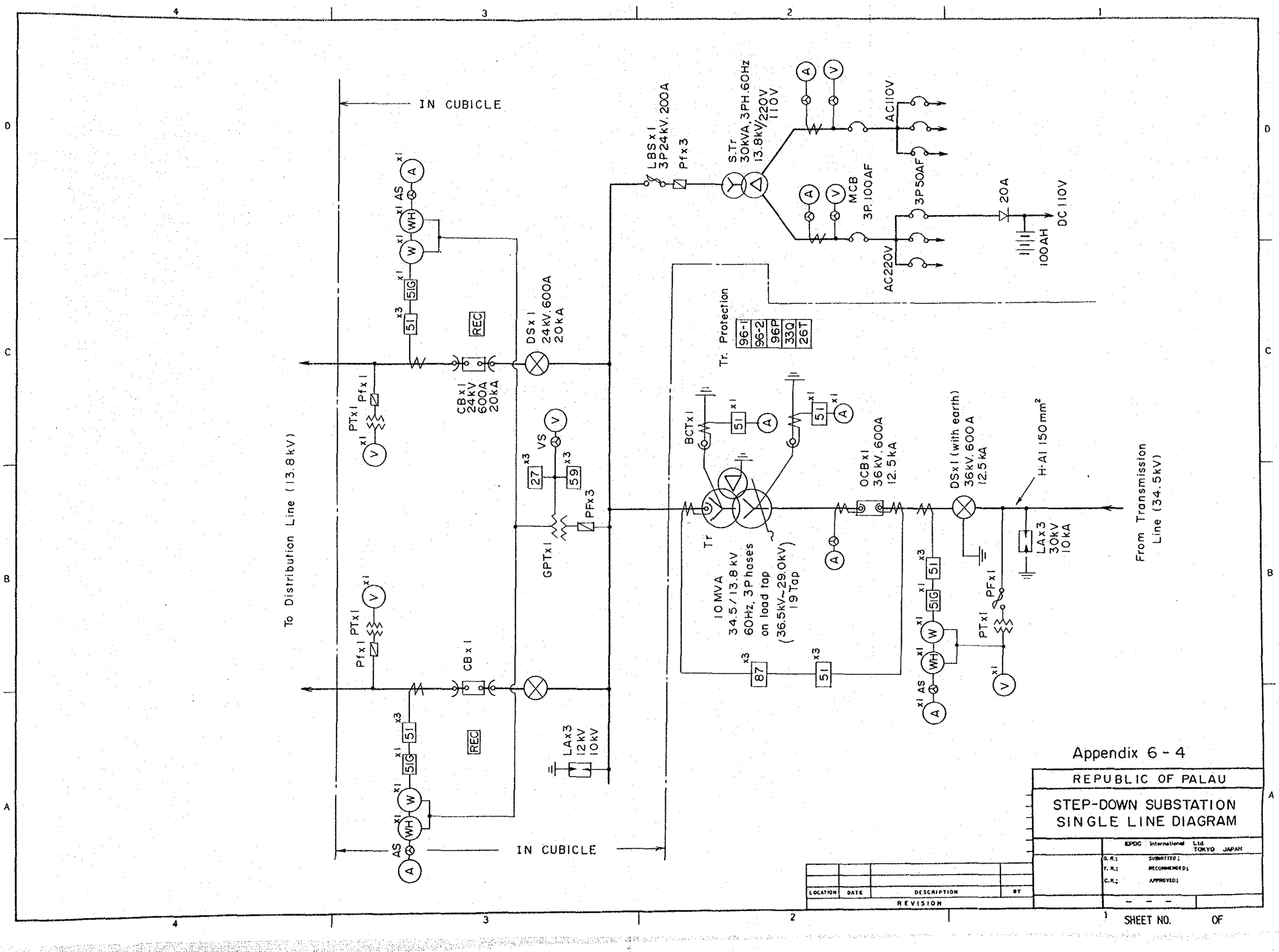
STEP-UP SUBSTATION
SINGLE LINE DIAGRAM

EPDC International Ltd. TOKYO JAPAN

D. R.; SUBMITTED;
T. R.; RECOMMENDED;
C. R.; APPROVED;

LOCATION	DATE	DESCRIPTION	BY
REVISION			

SHEET NO. OF



Appendix 6 - 4

REPUBLIC OF PALAU

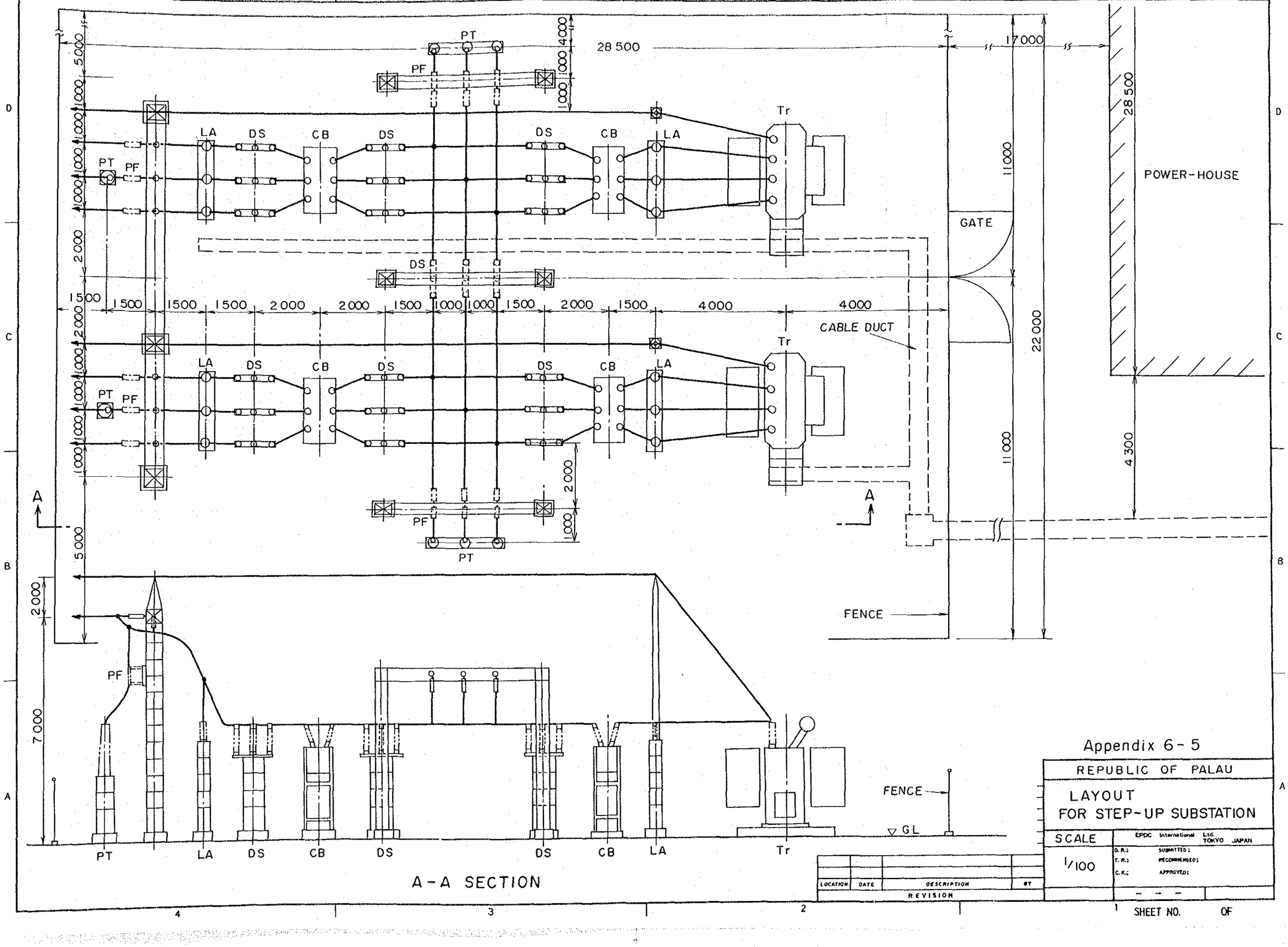
STEP-DOWN SUBSTATION
SINGLE LINE DIAGRAM

EPDC International Ltd.
TOKYO JAPAN

D.R.; SUBMITTED;
T.R.; RECOMMENDED;
C.R.; APPROVED;

LOCATION	DATE	DESCRIPTION	BY
		REVISION	

SHEET NO. OF



Appendix 6-5

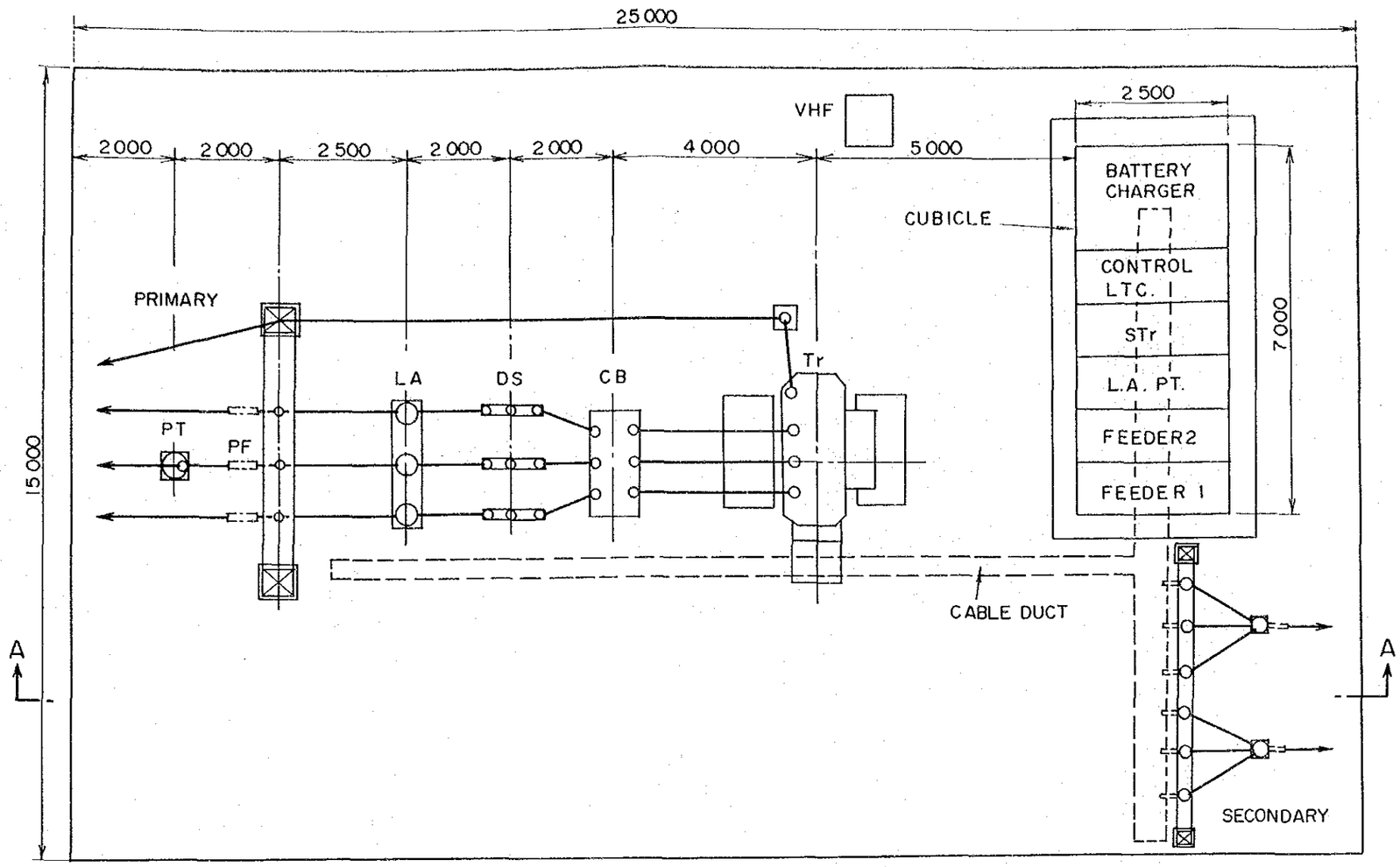
REPUBLIC OF PALAU

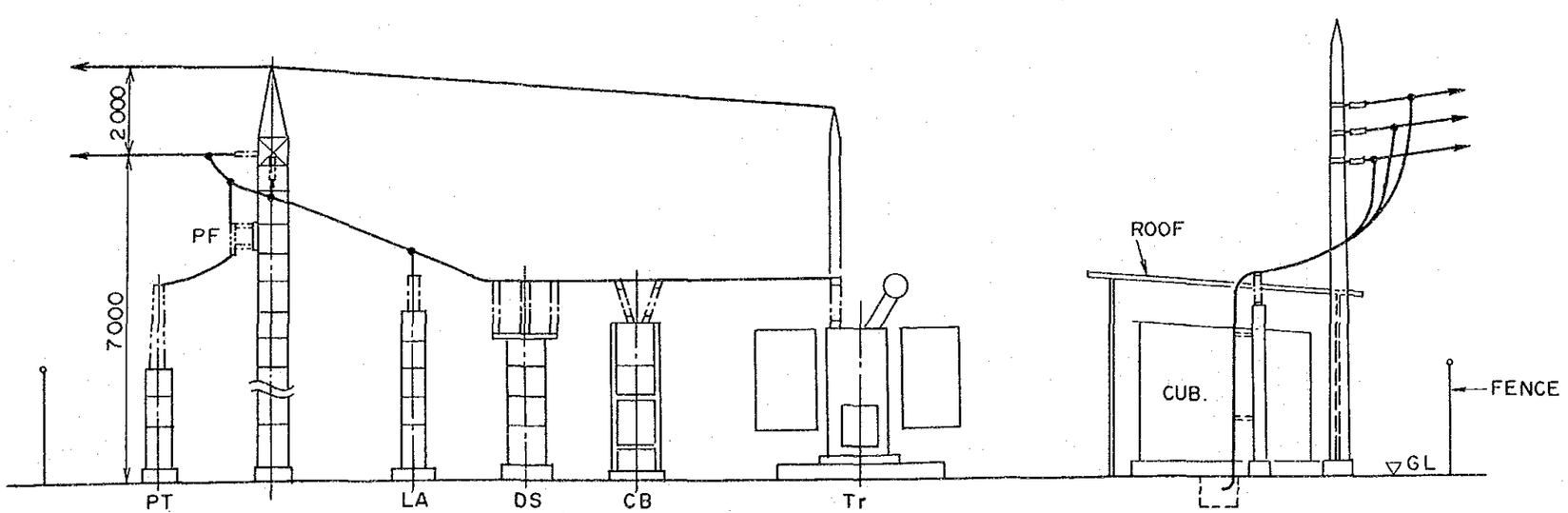
LAYOUT
FOR STEP-UP SUBSTATION

SCALE	EPDC International Ltd. TOKYO JAPAN
1/100	D. R.: SUBMITTED:
	T. R.: RECOMMENDED:
	C.K.: APPROVED:

LOCATION	DATE	DESCRIPTION	BY
REVISION			

SHEET NO. OF





A-A SECTION

Appendix 6 - 6

REPUBLIC OF PALAU

LAYOUT
FOR STEP-DOWN SUBSTATION

SCALE 1/100

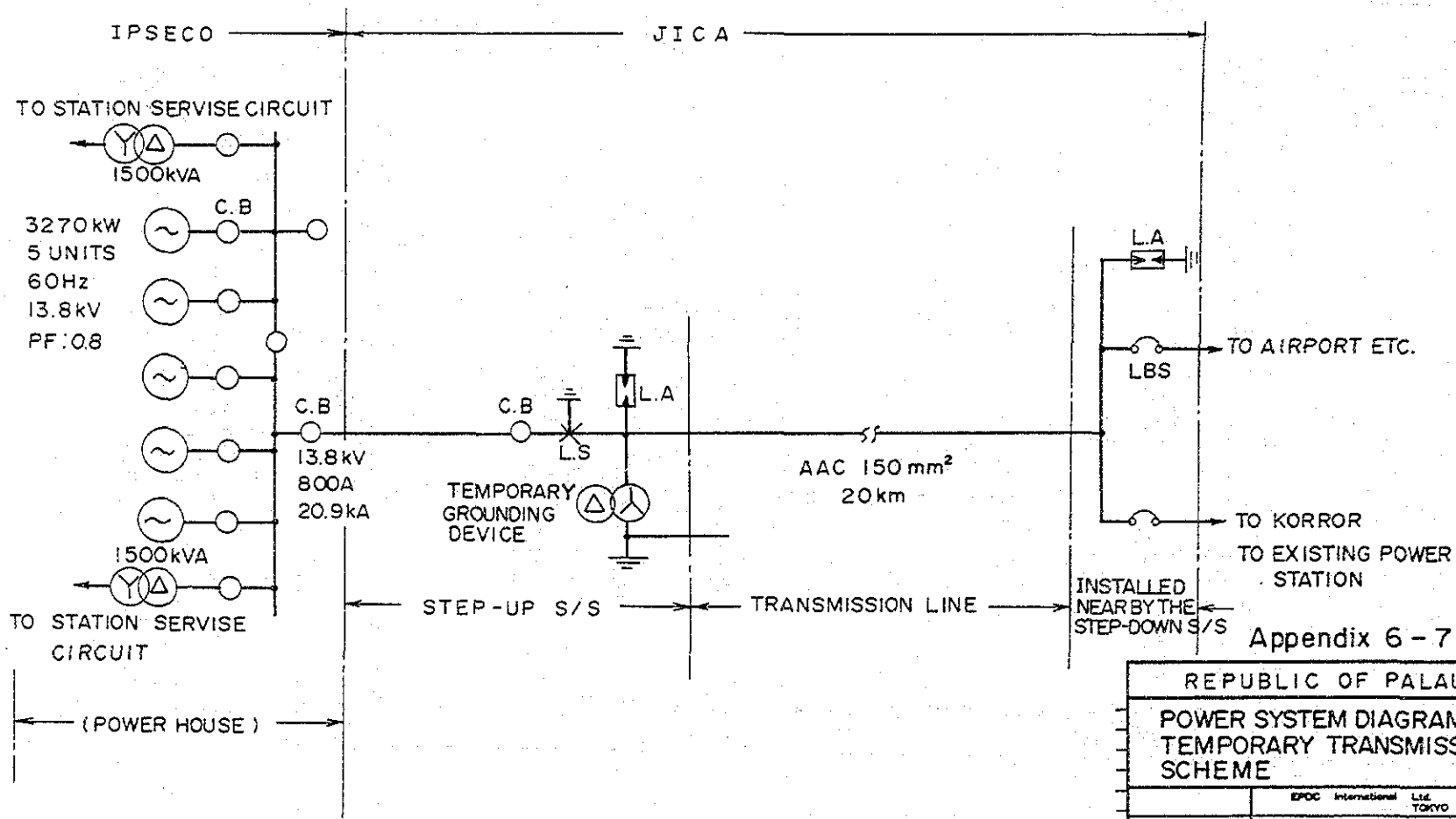
EPDC International Ltd. TOKYO JAPAN

D.R.; SUBMITTED;
Y.R.; RECOMMENDED;
C.R.; APPROVED;

LOCATION	DATE	DESCRIPTION	BY

REVISION

SHEET NO. OF



Appendix 6 - 7

REPUBLIC OF PALAU

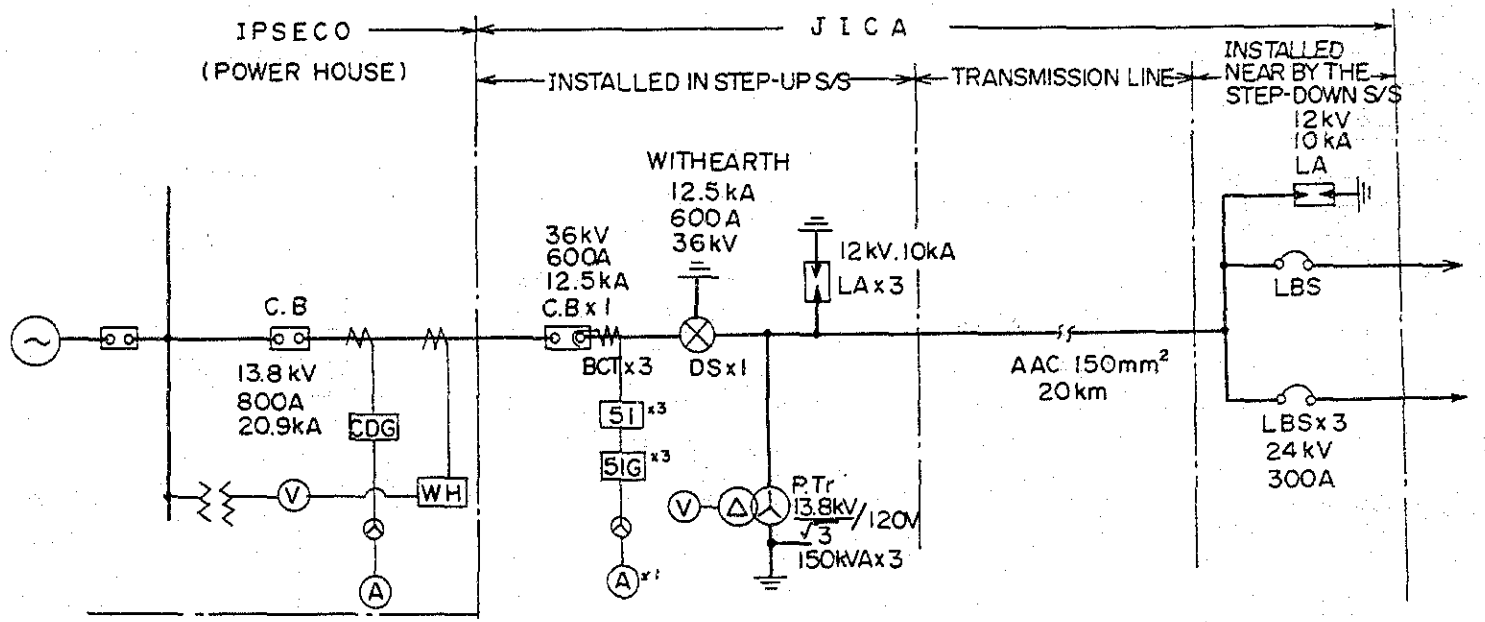
POWER SYSTEM DIAGRAM OF TEMPORARY TRANSMISSION SCHEME

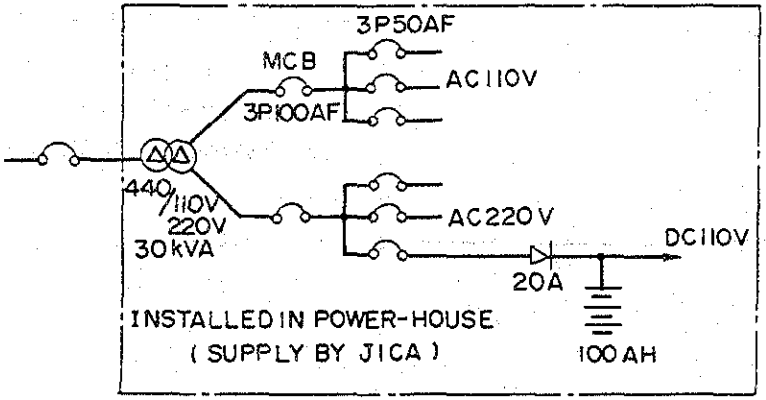
EPDC International Ltd. TOKYO JAPAN

D. R.: SUBMITTED:
T. R.: RECOMMENDED:
C. K.: APPROVED:

LOCATION	DATE	DESCRIPTION	BY
REVISION			

SHEET NO. OF





Appendix 6-8

REPUBLIC OF PALAU

SINGLE LINE DIAGRAM OF TEMPORARY TRANSMISSION SCHEME

EPDC International Ltd. TOKYO JAPAN

D. R.: SUBMITTED:
T. R.: RECOMMENDED:
C. R.: APPROVED:

LOCATION	DATE	DESCRIPTION	BY

REVISION

SHEET NO. OF

Calculation of Generating Cost of Aimeliik Power Plant

Annual Power Generation

The annual power generation is determined as 48,287,700 kWH/year, for the period of the life of machines and equipment of 15 years.

(i) The average load factor is assumed to be 70%, based on the record of generation in January, 1985.

[Calculation]

Weekdays: 2,274 kWH in the average

Holidays: 3,101 kWH in the average

Peak demand: 4,110 kWH

Average load factor = (2,274 x 2 + 3,101 x 5)/(4,110 x 7) = .70

(ii) The maximum power demand at present is 4,000 kW. The projection for 10 years is 9,000 kW. The average generation for the 10 years at the average load factor of 70% is 4,550 kWH/hour.

[Calculation]

1985: 4,000 kW x 70% = 2,800 kWH/hour

1985: 9,000 kW x 70% = 6,300 kWH/hour

(iii) Assuming the life of equipment and machines to be 15 years, and the annual rate of growth of generation for 10 to 15 years as 5.6% in average, the average generation for that period is 7,437 kWH/hour.

[Calculation of 5.6% growth rate]

The average increment of generation for the next 10 years
= [(6,300 - 2,800) kWH/hour]/10 years = 350 kWH/hour

[350 kWH/hour]/6,300 kWH (average generation after 10 years)
= 5.6%

[Calculation of average generation in 10 to 15 years future]

$[(6,300 + 350) + (6,650 \times 1.056) + (6,650 \times 1.056^2) + (6,650 \times 1.056^3) + (6,650 \times 1.056^4)]/5$ years

= 7,437 kWH

(iv) From above calculations, the average annual power generation for the calculation of the generating cost is 48,287.7 MWH/year.

Average generation:

(4,550 kWH/h x 10 years + 7,437 kWH/h x 5 years)/5 years
= 5,512/3 kWH/h

Average annual generation:

5,512.3 kWH x 24 x 356 = 48,287,748 kWH/year
.... 48,287,700 kwH/year

∘ Construction Cost

Subtract the construction cost of the oil tank facility, 6 million dollars from the total construction cost:

$28,965,800 - $6,000 = $22,965,800

∘ Total Annual Expense

Capital cost: $2,363,500

Although the Government of Palau do not adopt the concept of depreciation, the repayment of the loan of the fund for the construction of the power plant is to be a direct financial burden of the Government of Palau which is supported by the financial assistance of the United States, if the capital cost is not paid by the revenue of electric utility operations. For this reason, the repayment and the interest of the loan is counted as the capital cost, which will be paid back in the 15 years, the life of the equipment and facilities.

(Refer Material 8-2 for the details of the loans.)

Total loan: $42,478,700

Total interest: $17,666,400

Loan plus interest: $50,145,100

Shear to be borne by the power plant cost:

$50,145,100 x (22,965,800/32,478,700) = $35,452,600

Annual capital cost:

$35,452,600/15 years = $2,363,500

Direct cost: $1,115,100

(Repairing expense): 2% of the construction cost

$22,965,800 x 0.02 = $459,300

(Miscellaneous expense): 0.4% of the construction cost

$22,965,800 x 0.004 = $91,900

(Personnel expense):

The annual average salary for the employee of the Bureau of Public Works in the Ministry of National Resources is around 7 thousand dollars, according to the Government of Palau. The increase of the personnel expense for 15 employees, or $105,000, is added to the presumable personnel expense in fiscal 1984 of $342,600.

$342,600 + $105,000 = $447,600

(Cost of lubrication oil):

At rate of consumption; 1.6 g/kWH, specific gravity; 0.91, unit cost; $1.37/liter (=$5.18/gal.)

1.6 x 1/1,000 x 1/.91 x 48,287,700 kWH x 1.37 = $116,300

(Fuel cost):

At rate of consumption; 210 g/kWH, specific gravity; .95, unit cost; 21 cents/liter (=79 cents/gal.)

210 x 1/1,000 x 1/.95 x 48,287,700 kWH x .21 = $2,241,600

- Total Annual Expense: $5,720,200
- Expense Excluding Capital Cost: $3,356,700

Generating Cost:

Including capital cost: $0.118/kWH .... 12 cents/kWH

Excluding capital cost: $0.0695/kWH ... 7 cents/kWH

Appendix 8-2-(1) Details of the Loans From British Banks

(Unit: US$ 1,000.-)

Consolidated Basis of Three Loans

Repayment schedules of each loan are as per attached next page. Appendix 8-2-(2)

⊗ "Equivalent to Construction Cost" indicates that a pro-rata portion of the power plant construction cost against total repayment amount.

Date	Borrowing	Repayment of Principal Ⓐ	Balance of Borrowing	Interest Payment (Calculated at 11.25% p.a.) Term	Int. Amount Ⓑ	Repayment Amount in Each Fiscal Year Ⓐ+Ⓑ=Ⓒ	Equivalent to Construction Cost (Ⓒ×70.7%) ⊗
1983. 6. 8	32,478.7		32,478.7				
				1983.6.8 - 8.31	862.7	862.7	609.9
9. 1			32,478.7	(85 d/s)			
				1983.9.1-84.2.29	1,847.2		
1984. 3. 1			32,478.7	(182 d/s)			
				1984.3.1 ~ 8.31	1,867.5	3,714.7	2,626.3
9. 1			32,478.7	(184 d/s)			
				1984.9.1-85.2.28	1,837.1		
1985. 3. 1		2,282.0	30,196.7	(181 d/s)			
				1985.3.1 - 8.31	1,736.2	9,994.6	7,066.2
9. 1		4,139.2	26,057.5	(184 d/s)			
				1985.9.1-86.2.28	1,473.9		
1986. 3. 1		4,139.2	21,918.3	(181 d/s)			
				1986.3.1 - 8.31	1,260.3	8,730.7	6,172.6
9. 1		1,857.3	20,061.0	(184 d/s)			
				1986.9.1-87.2.28	1,134.7		
1987. 3. 1		1,857.3	18,203.7	(181 d/s)			
				1987.3.1 - 8.31	1,046.7	5,896.0	4,168.5
9. 1		1,857.3	16,346.4	(184 d/s)			
				1987.9.1-88.2.29	929.7		
1988. 3. 1		1,857.3	14,489.1	(182 d/s)			
				1988.3.1 - 8.31	833.1	5,477.4	3,872.5
9. 1		1,857.3	12,631.8	(184 d/s)			
				1988.9.1-89.2.28	714.5		
1989. 3. 1		1,857.3	10,774.5	(181 d/s)			
				1989.3.1 - 8.31	619.5	5,048.6	3,569.4
9. 1		1,857.3	8,917.2	(184 d/s)			
				1989.9.1-90.2.28	504.4		
1990. 3. 1		1,857.3	7,059.9	(181 d/s)			
				1990.3.1 - 8.31	405.9	4,624.9	3,269.8
9. 1		1,857.3	5,202.6	(184 d/s)			
				1990.9.1-91.2.28	294.3		
1991. 3. 1		1,734.2	3,468.4	(181 d/s)			
				1991.3.1 - 8.31	199.4	3,962.1	2,801.2
9. 1		1,734.2	1,734.2	(184 d/s)			
				1991.9.1-92.3.1	99.2		
1992. 3. 1		1,734.2	0	(183 d/s)		1,833.4	1,296.2
	32,478.7	32,478.7			17,666.4	50,145.1	35,452.6

Appendix 8-2-(2)

(Unit : US$ 1,000.-)

Date	Repayment	Balance	Interest (11.25% fixed)
Amount : US$ 24,278,700 Lender : International Westminster Bank PLC Guaranteed by ECGD			
1983.6.8		24,278.7	
1985.9.1	1,734.2	22,544.5	
1986.3.1	1,734.2	20,810.3	
1986.9.1	1,734.2	19,076.1	
1987.3.1	1,734.2	17,341.9	
1987.9.1	1,734.2	15,607.7	
1988.3.1	1,734.2	13,873.5	
1988.9.1	1,734.2	12,139.3	
1989.3.1	1,734.2	10,405.1	
1989.9.1	1,734.2	8,670.9	
1990.3.1	1,734.2	6,936.7	
1990.9.1	1,734.2	5,202.5	
1991.3.1	1,734.2	3,468.3	
1991.9.1	1,734.2	1,734.2	
1992.3.1	1,734.2	0	
Amount : US$ 1,354,200 out of US$ 8,200,000 Lender : County Bank.			
1983.6.8		1,354.2	
1985.9.1	123.1	1,231.1	
1986.3.1	123.1	1,108.0	

(Unit : US$ 1,000.-)

Date	Repayment	Balance	Interest (11.25% fixed)
1986.9.1	123.1	984.9	
1987.3.1	123.1	861.8	
1987.9.1	123.1	738.7	
1988.3.1	123.1	615.6	
1988.9.1	123.1	492.5	
1989.3.1	123.1	369.4	
1989.9.1	123.1	246.3	
1990.3.1	123.1	123.1	
1990.9.1	123.1	0	
Amount : US$ 6,845,800 out of US$ 8,200,000 Lender : County Bank			
1983.6.8		6,845.8	
1985.3.1	2,282.0	4,563.8	
1985.9.1	2,281.9	2,281.9	
1986.3.1	2,281.9	0