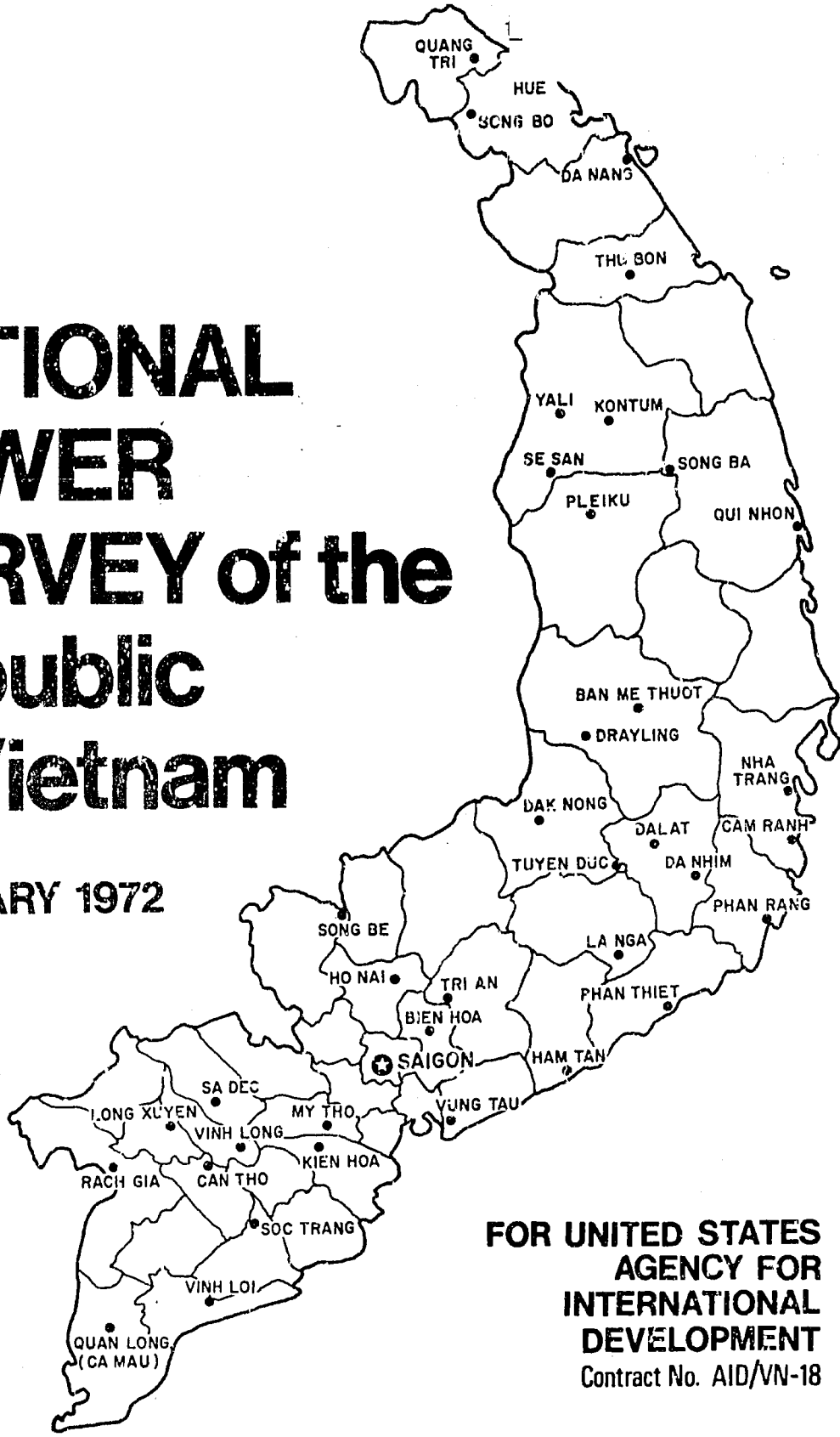
NATIONAL POWER SURVEY of the Republic of Vietnam

FEBRUARY 1972



FOR UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

Contract No. AID/VN-18

THE NATIONAL POWER SURVEY TEAM REPORT

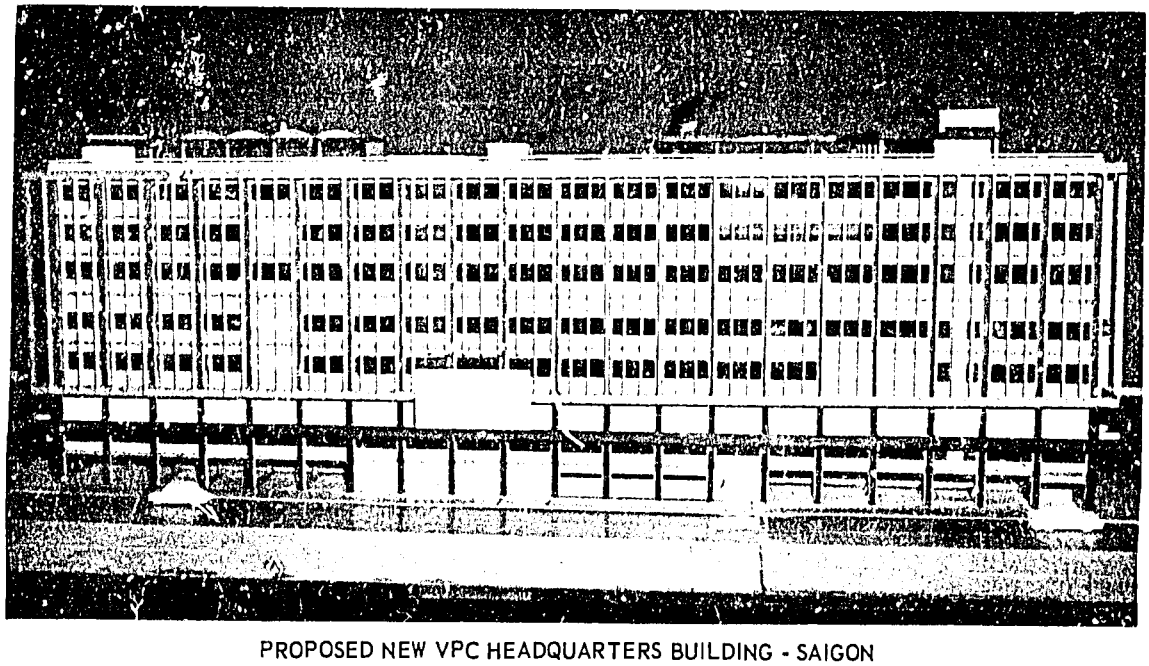
ON

THE REPUBLIC OF VIETNAM

FEBRUARY, 1972

Prepared for
The United States Agency for International Development

PRESENT VPC HEADQUARTERS BUILDING - SAIGON



PROPOSED NEW VPC HEADQUARTERS BUILDING - SAIGON

REPORT

OF

THE NATIONAL POWER SURVEY TEAM

ON

THE REPUBLIC OF VIETNAM

PREPARED FOR:

The United States Agency for International Development under Contract No. AID/vn-18, PIO/T No. 730-356-3-80148 dated August 14, 1967; Amendment No. 3, PIO/T No. 730-380-3-9191091 dated April 1, 1971.

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February 15, 1972

Mr. Robert H. Nooter, Deputy Coordinator
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Washington, D. C. 20523

Dear Mr. Nooter:

In accordance with your request and in agreement with the scope of work set forth in Contract AID/vn-18, Amendment 3, we are pleased to transmit to you the final report of the National Power Survey Team.

The National Power Survey can do much toward the development of electric power and for the enhancement of the economic and social development of Vietnam. However, such a survey is not a rigid plan for the development of the industry and must be reviewed periodically. It can be adjusted as needed when decisions are made concerning specific projects.

We are especially pleased with the meaningful participation of the Vietnamese in this study. Members of the Vietnam Power Company, Ministry of Public Works, and others were active throughout the entire study period and worked in close collaboration with the study team. With appropriate support, they will have the capability of carrying on reviews in the future.

In transmitting this report to you, I am mindful of the very excellent work done by members of the team under the leadership of E. Robert deLuccia. Also, Harry Tauber has given much of his background, experience, and enthusiasm in providing overall guidance to the project.

We are happy to have been of service to the people of Vietnam and the United States. I do wish you to know of our continuing interest and our willingness to assist in this kind of constructive endeavor. Each of us personally is quite dedicated to the cause of bringing about greater understanding between nations and peoples by making our experience available.

With every good wish.

Sincerely,

Walker Cisler

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Bibliography

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Taiwan Power Company
US Army
US Navy

GLOSSARY

ABBREVIATIONS

ACSR ..... aluminum conductor steel reinforced
ADB ..... Asian Development Bank
ARVN ..... Army, Republic of Vietnam
CCC ..... Cooperative Coordinating Committee
CEE ..... Compagnie des Eaux et d'Electricite de l'Indochine
COBOL ..... Common Business Oriented Language
CPM ..... China Power Mission
DLF ..... development loan fund
DPC ..... data processing center
ECAFE ..... Economic Commission for Asia and the Far East
EHV ..... extra high voltage
EOV ..... Electricity of Vietnam
EXIM Bank ..... Export-Import Bank of Japan
f ..... franc
FORTRAN ..... Formula Translation
FPC ..... Federal Power Commission
GM ..... General Motors
GNP ..... gross national product
GVN ..... Government of Vietnam
IBM ..... International Business Machines
JDG ..... Joint Development Group
Korea ..... Republic of Korea
M ..... Thousand, as in US$M
$\overline{M}$ ..... Million, as in US$$\overline{M}$
MACV ..... Military Assistance Command Region V
MAT ..... Management Advisory Team
M.cmil ..... Thousand circular mils
Mekong Committee ..... Committee for the Coordination of Investigations of the Lower Mekong Basin
MLRAFD ..... Ministry of Land Reform and Agriculture and Fishery Development
MST ..... Management Services Team
NPS ..... National Power Survey
NUC ..... National Utilities Commission
NUEC ..... National Union of Electric Cooperatives
ONDEE ..... Office National de Re-Equipment des Installations de Production et de Distribution d'Energie Electrique
PTP ..... pole treatment plant
PTT ..... Post, Telephone, and Telecommunications
R & R ..... renewal and reconstruction
REA ..... Rural Electrification Administration
RECF ..... Rural Electric Cooperative Fund
RED Plan ..... Rural Economic Development Plan
ROC ..... Republic of China
SCEE ..... Societe Centrale d'Eclairage et d'Energie
SIPEA ..... Societe Indochinoise pour les Eaux et l'Electricite en Annam
SOC ..... Society of Control
SPC ..... Saigon Power Company
UNEDI ..... Union Electrique d'Indochine
US ..... United States of America

US$ ..... US Dollar = VN$275
USAID ..... US Agency for International Development
USIS ..... US Information Service
Vietnam ..... Republic of Vietnam
VN$ ..... Piastre = US$0.00364
VNRS ..... Vietnam National Railway System
VPC ..... Vietnam Power Company

UNIT SYMBOLS

A ..... ampere
Btu ..... British thermal unit
cm ..... centimeter
cm^3 ..... cubic centimeter
cmil ..... circular mil
°C ..... degree Celsius (temperature)
°F ..... degree Fahrenheit (temperature)
ft ..... foot
ft/min ..... foot per minute
ft/s ..... foot per second
ft^2 ..... square foot
ft^3 ..... cubic foot
ft^3/min ..... cubic foot per minute
ft^3/s ..... cubic foot per second
G ..... giga (10^9)
Hz ..... hertz
hp ..... horsepower
k ..... kilo (10^3)
km ..... kilometer
km^2 ..... square kilometer
kV ..... kilovolt
kVA ..... kilovoltampere
kW ..... kilowatt
kWh ..... kilowatthour
M ..... mega (10^6)
m ..... meter
m^2 ..... square meter
m^3 ..... cubic meter
m^3/s ..... cubic meter per second
mm ..... millimeter
mil ..... mil (1 mil = 0.001 inch)
mill ..... mill (1/1000 of US$1)
MVA ..... megavoltampere
MW ..... megawatt
MWh ..... megawatthour
s ..... second (time)
V ..... volt
VA ..... voltampere
W ..... watt
Wh ..... watthour

OBJECTIVES

The objectives of the National Power Survey (NPS) for the Republic of Vietnam (Vietnam) are set forth in the Scope of Work which is quoted as follows:

"A. Geographical description and economic picture of the country with emphasis on the future, especially in the areas of industry and agriculture.

"B. General Statement of energy resources of Vietnam:

1. Fossil fuels, indigenous and foreign.
2. Hydro, including the Mekong development.
3. Nuclear.

"C. Past history of the electric power industry in Vietnam. Trace the development of the load and the enterprises that arose to meet it.

"D. Present electric power situation in Vietnam showing how current loads are being met. This should include not only VPC but private generation, municipally operated systems, co-ops, the French franchise companies still operating, etc.

"E. Future total power load estimated for a 15-year period on two bases:

1. The load that will result with the expenditure of a reasonable total of construction funds.
2. The load that will result with the expenditure of ample funds to meet all reasonable needs.

"F. System development. How this load might be met for the 15-year period under the two bases above and scheduled as to timing. This should include:

1. General system expansion that considers location, size, type, and timing of generation with adequate provisions for reserves. This will include a consideration of the mix of thermal, hydro, gas turbine, or diesel whichever is most appropriate for the Vietnam program.
2. Transmission and distribution plans to deliver the output of item 1 above.
3. Proposals for integrating the co-ops, municipals, and industrial self-generation.
4. Assessment of French franchises which have not yet expired and the practicability of their incorporation into the VPC system.
5. Recommendations for the disposition of the considerable 60-cycle diesel generating equipment installed in Vietnam.
6. Consideration of factors related to integrated operation.
7. Consideration of environmental factors.

"G. Electric distribution. Development of a long-range distribution plan considering the future advent of increased loading due to air conditioning, television, and other major appliances and the need for eliminating the present practice of illegal submetering. The results of the work performed by Commonwealth Associates and by Sanderson and Porter should be reviewed and fully utilized.

"H. Accounting.

1. A review should be made of accounting procedures, both operating and capital, so that accurate and timely management data can be provided and also for subsequent cost of service studies in connection with rate analysis and other financial considerations.
2. A review should be made of the property records to determine their accuracy and ability to support the plant accounts as shown in the Federal Power Commission classification.

3. Depreciation practices and rates should be examined to determine their suitability.
4. The use of "interest during construction" should be reviewed.

"I. Financial Management.

1. Analysis and forecast of revenue, expense, and earnings for the 15-year period.
2. Forecast of cash flow for the 15-year period must be made with appropriate considerations of depreciation, loans, etc.
3. Review of VPC computer equipment and experience to date and recommendations for future data processing plans.

"J. Construction Financing.

1. Forecast of construction cost estimates for the 15-year period, under each of the major categories of system development such as thermal generation, hydro generation, substations, transmission, etc.
2. Recommendations to VPC regarding appropriate capital funding projections as regards mix of long– and short–term credits. Recommendations regarding the ratio of internally generated funds and borrowed capital with a view toward qualifying VPC rapidly for attracting capital from free world sources.

"K. Rates for service and relationship to Regulatory Commission.

1. Review the present rate schedules available for the major classes of customers and suggest modifications in principle where indicated. Where rate making information is not available, determine what programs should be initiated to secure such information.
2. Review the legislation establishing the Public Regulatory Commission, its present stage of development, and assess its probable future influence on power development in Vietnam.

"L. Organization structure and personnel management.

1. Recommendations for strengthening VPC staff in corporate management.
2. A broad look at the present organization structure and its practices is required in view of the significant developments which have taken place since 1967 and the future growth contemplated.

   In this connection, it is significant that in the 1967 Management Advisory Team study, a portion of the text was devoted to recommendations for the reorganization of the utility companies as they existed at that time. These recommendations had an important influence in the reorganizations which actually took place since 1967.

   A comparable analysis is desired based on the present circumstances and future developments which can be foreseen at present and the choices that could be taken such as a decentralized organization structure vs a strongly centralized one. Particular attention will be given to organization and management of VPC staff with reference to the 1971–1975 period of rapid buildup to near 1000 MW size under abnormal conditions.

3. Review personnel practices involving job motivation, promotion, salary administration, and related matters because of the strong impact these have on morale. Training programs at all levels should also be examined and suggestions made if appropriate."

SECTION I

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SECTION I

SYNOPSIS

The purpose of the NPS for Vietnam is to lace into reasonable definitive perspective the rojected needs of its electric power industry 'hich is a basic component of the economic and ›cial progress of Vietnam as a developing nation. .lso, in broad terms, the purpose is to set forth a lausible course of development for the electric ower industry through 1986.

In so stating, it is recognized that the overall ›ility of the Government of Vietnam (GVN) to rovide, or have provided, sufficient foreign ‹change to cover all claimant needs will be mited.

Abundant electric power is necessary to a 'owing economy. If the economy of the country not growing, or is growing at a slower rate than ›ped for, the electric power supply program set ›rth in this report can be altered to fit the tuation. However, care should be exercised to ›termine if the supply of energy is holding back .e potential growth of the economy. This is a atter of high national policy or perhaps ternational policy with respect to provision of reign exchange and is outside the scope of is report.

The plans proposed can be handled like an cordion – they can be compressed in time or ey can be drawn out. Security conditions alone ay cause an undeterminable delay in the nstruction of hydro projects and transmission cilities and it may be necessary to rely on the nstruction of more thermal plants.

The report does not intend to present an gument for a particular rate of growth for the onomy of Vietnam nor for a potential plan of stem development within a certain time frame. does provide a highly flexible plan with respect timing of generation installations and nsmission facilities and an opportunity to study ernate possibilities.

In the first five years, the report points out at it is possible, physically and economically, to ›et the critical demand and intervening load ›wth so as to be able to provide power for new d expanded industry and to adopt rate uctures which will encourage and promote ›nomic growth.

The electric power industry in Vietnam is sentially VPC which is the sole chartered supplier of electric power with the exception of a small French company whose franchise terminates in 1975. It is wholly owned by GVN which has proclaimed that it is to be operated as a commercial enterprise without GVN subsidy.

There is a mounting pent-up demand for electric power which has reached critical proportions. Existing facilities are able to handle only about half of the immediate pent-up demand. In an attempt to help to alleviate the situation, VPC is installing costly diesel engines which have now become its principal available production source.

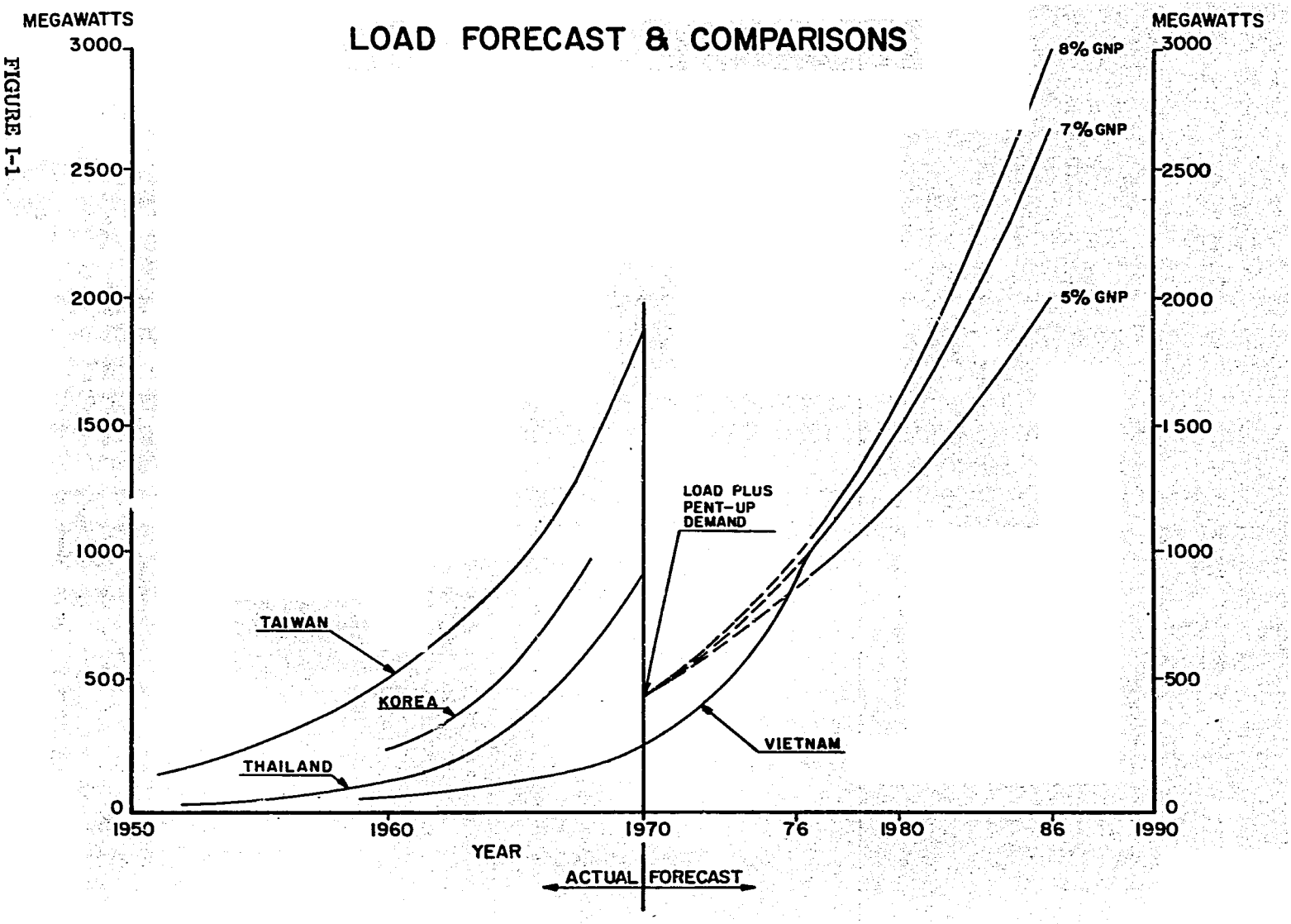
VPC has embarked on a five-year program to overtake the pent-up demand by 1976. The work involves, principally, the rehabilitation of the war damaged Da Nhim hydroelectric plant (160 000 kW) and 230–kV transmission line to Saigon, the completion of construction of two 66 000–kW thermal units at Thu Duc, the construction of a 33 000–kW thermal unit at Can Tho, and the construction of two 125 000–kW thermal units in the Saigon area with the first unit to be available in 1975. The necessary transmission and distribution lines are also included in the program.

The load projections in this report are not predictions nor is the system development plan a mandate. The plans are not blueprints but must be reviewed at least once each year in the light of the overall national situation and from the viewpoint of VPC.

The lack of meaningful historical statistical data due to the pent-up demand did not permit extrapolation methods to be used in projecting power needs.Therefore, the pent-up demand was calculated and used as the point of take-off for the load projections shown on Figure I–1. This figure shows three load projections based on five, seven, and eight percent rates of annual growth of the Gross National Product (GNP). It also shows a comparison of these load projections with the historical load curves for Taiwan, the Republic of Korea (Korea), and Thailand, which are also developing countries.There is a close correlation of these load curves and the load projection based on the seven percent rate. The Joint Development Group (JDG), which has projected the postwar economy of Vietnam,

2

FIGURE I-1


LOAD FORECAST & COMPARISONS
MEGAWATTS
3000
2500
2000
1500
1000
500
0
MEGAWATTS
3000
2500
2000
1500
1000
500
0
8% GNP
7% GNP
5% GNP
LOAD PLUS
PENT-UP
DEMAND
TAIWAN
KOREA
THAILAND
VIETNAM
1950
1960
1970
76
1980
86
1990
YEAR
ACTUAL
FORECAST

concluded that a seven percent rate was achievable and might be exceeded.[1] After careful consideration, the load projection based on a seven percent annual rate of growth of the GNP was selected as the recommended basis for planning system development.

The Scope of Work included requests for two load projections and system plans. One was to be based on a restricted availability of construction funds and the other on ample funds to meet reasonable needs. Two system development plans (Plan B and Plan C, respectively) were prepared in response to these requests. The load projection which was developed based on restricted funds (Plan B) was equivalent to an annual growth in GNP of 5.5 percent. The system development plan, under the assumption of ample funds to meet reasonable needs (Plan C), is based on the load projection relating to a seven percent annual growth of GNP. At seven percent GNP growth, it is assumed that industrial sales could increase from an estimated 55 percent of total sales in 1975 to 65 percent in 1986. Industrial demand would increase from 300 MW in 1975 to 1560 MW by 1987. The total demand by 1987 would be 2680 MW.

The amount of capital which will be required by VPC in comparison to its present expenditures is very large, and it is also relatively large considering Vietnamese capital requirements for purposes other than electric power. With this in mind, an alternate plan (Plan A) was developed as shown in Figure I-2. Plan A is also based on a seven percent annual rate of growth of GNP but has a lesser amount of generating reserves than Plan C. It is recommended that Plan A be used for planning purposes, initially, with a shift to Plan C whenever sufficient funds become available. It is recognized that insufficiency of funds may determine that Plan B, or less, is the only possibility.

Basically, all plans employ the same generating facilities, but the timing of the installations is varied. Each of the plans will require over US$1 billion in the 15-year period as shown below. Plan C will cost US$108 million more than Plan A.

[1]Joint Development Group, *The Postwar Development of the Republic of Vietnam: Policies and Programs*, Volume One, Volume Two, and Summary. Postwar Planning Group, Saigon; Development and Resources Corporation, New York. March 1969. All references to a JDG report and all quotations attributed to JDG are from these editions.

Comparison of Plans A, B, and C
Unfinanced Construction Funds*
1972–1986 Period

	US$ Million		
	Plan A	Plan B	Plan C
Foreign	894.7	772.8	972.7
Local	382.1	323.5	412.1
Total	1 276.8	1 096.3	1 384.8

**Does not include funds already available.*

These large needs must compete with the other essential foreign capital needs of Vietnam and a very careful ordering of priorities will have to be made by GVN if the nation is to have sufficient electric energy to support a viable economic growth.

All cost estimates have been on the basis of 1971 costs and at an exchange rate of VN$275 to US$1. No allowance has been made for any devaluation of the United States (US) dollar nor has any allowance been made for future inflation. An annual review of cost estimates, particularly for projects for which immediate or early construction is contemplated, is the only practical way to assume that the cost estimates will reflect existing conditions.

Vietnam has practically no fuel resources and must import all of its needs. Fortunately, it does have a very large potential for the development of hydroelectric projects (over 4 million kW). The steepness of the terrain generally precludes the construction of storage reservoirs of sufficient capacity in the projected system to supplement a deficiency of hydro energy in dry years with low-stream flow.

There is very little hydrological information for most of the potential hydroelectric power sites and very little, if any, other field information except in a very few instances. Thus, some of the projects selected for inclusion in the system plans may be found to vary significantly in desirability and economics later. Selection of other potential projects may have to be made or other projects may be found to be better than some which were selected.

The plan must be considered to be only a basis for planning under the conditions and with the knowledge available when it was prepared. Annual review and reworking of the load projections and the plan in the light of new conditions and information should be a normal exercise.

A progressive plan for a 230–kV backbone

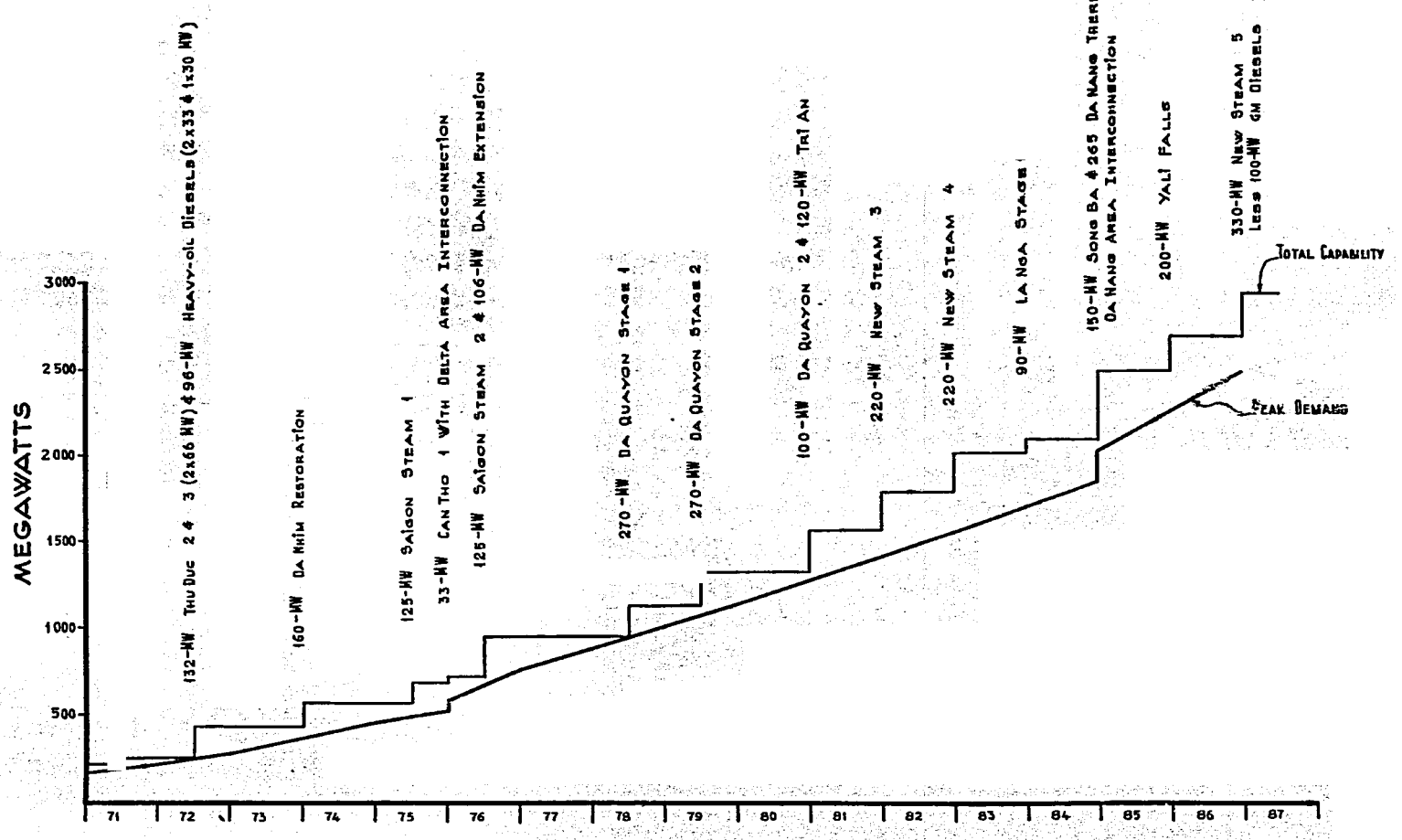
4'

FIGURE I-2

— PLAN A — (RECOMMENDED)

INTERCONNECTED SYSTEM

GENERATION EXPANSION PLAN



transmission system with 138-kV subtransmission has been developed as shown in Figures I-3, I-4, I-5, and I-6. The maps show, progressively, in five-year intervals, the buildup of the system including interconnections to province centers. By 1986, all of the province centers will have been brought into the interconnected system as shown in Figure I-7 with the exception of Bao Loc and Gia Nghia, which are small communities in the remote areas of the central highlands. This plan is subject to change as future conditions may indicate.

In order to be able to provide sufficient electric power, VPC, in addition to developing a sound system plan, must also develop a sound financial plan so that it will be in a position to attract the large amounts of capital required.

On the basis that VPC is to be operated as a commercial utility, a financial plan showing the source and disposition of necessary funds has been developed as shown in Table I-1. This plan is similar to those used by private or commercial-type utilities. Essentially, it raises funds by the issuance of equity and debt securities, i.e., stocks and bonds, and internally generated funds. The rates are designed to pay interest on the bonds at six percent with the equity earning ten percent. The equity earning is generally related to the bond interest and is not a necessary fixed amount. The bonds are not amortized and, when they become due in some 20 or 30 years, will be refunded by sale of a new issue of bonds.

US grants to GVN for use by VPC require interest payments by VPC to GVN of about six percent. Funds from other sources have been made available to VPC at three percent interest. International banks are loaning money at rates of six percent and less. GVN now guarantees payment of interest and principal, and it is assumed that this will continue for 15 years or until VPC has an acceptable credit rating enabling it to earn favorable interest rates. On this basis, six percent has been used for cost of money for construction purposes. With interest rates for debt at six percent, equity capital should earn about ten percent.

The equity of the owner of VPC, which is GVN, is shown in the VPC book entries at December 31, 1970, as US$46 million and includes US$2.6 million of capital investment, or stock, with the difference of US$43.6 million largely made up of plant donated by the US, Japanese war reparations funds, and renewal and reconstruction (R&R) funds received from customers and classified as customer contributions.

The financing proposed for Plan A includes provision for the sale of stock in the years indicated in Table I-1. Since GVN is the sole owner, it would buy the stock and increase its capital stock investment from US$2.5 million to US$84 million in the annual amounts indicated. This additional stock purchase is not a subsidy to VPC by GVN, but an added investment in the business for which returns are expected. Additional equity is provided by retaining all or part of the net income in VPC for use in helping to meet fund requirements. This, together with the new stock purchases, increases the owner's equity and makes his business more valuable.

Depreciation is taken in two parts. First, the plant now on the books is depreciated at present VPC depreciation rates averaging about ten percent per year. This plant will be wholly depreciated by 1982. All subsequent plant in service is depreciated an average of 3.5 percent per year. It will be noted from Table I-1 that the depreciation for 1982 and 1983 is less than 1981. This is due to the fact that the depreciation on the old plant is finished with only a minor effect on the depreciation accrual.

For purposes of illustration, the plans show convertibility of currency, or the ability to trade Vietnam piastres in the world markets, by 1980. This year was selected in order to show the effect of the change. It is not a forecast but might well occur before 1986 depending, of course, on the development of the economy, the policies of the government, and other factors. If convertibility is not attained, VPC can continue project-type financing with only a minor impact on earnings and rates. By project-type financing is meant the financing of specific projects on a loan basis from soft loan institutions and/or loans backed by GVN rather than selling stocks or bonds.

VPC does not have the authority to convert Vietnamese money into foreign exchange and must have this done by GVN. GVN must guarantee any loan made to VPC since it, in effect, pays the foreign bills. As a practical matter, GVN will have to continue to guarantee such loans until VPC has qualified itself in the world markets and no longer requires the financial guarantees that GVN now provides to loan institutions on VPC's behalf. The VPC foreign exchange requirements, in addition to project financing, are shown on Table I-2.

EXISTING VPC TRANSMISSION SYSTEM 1971

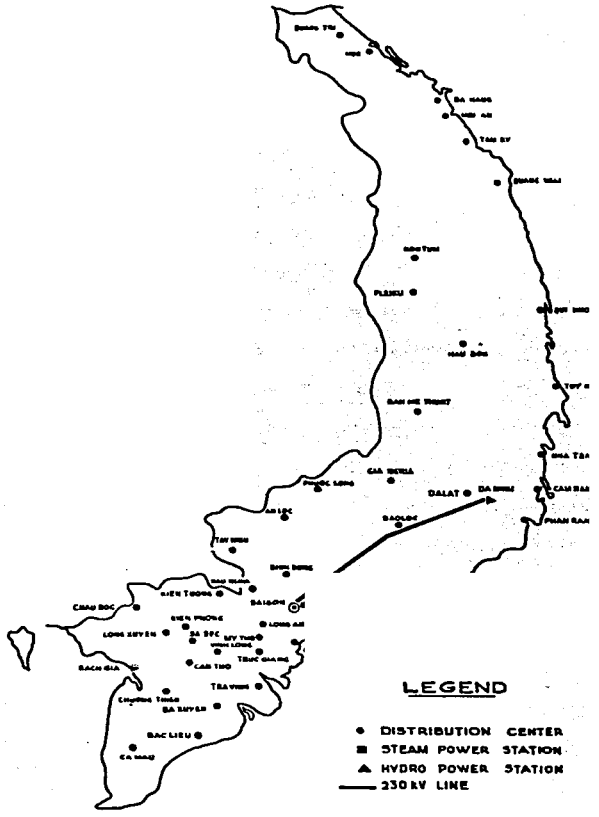


FIGURE I-3

TRANSMISSION SYSTEM STUDY 1976

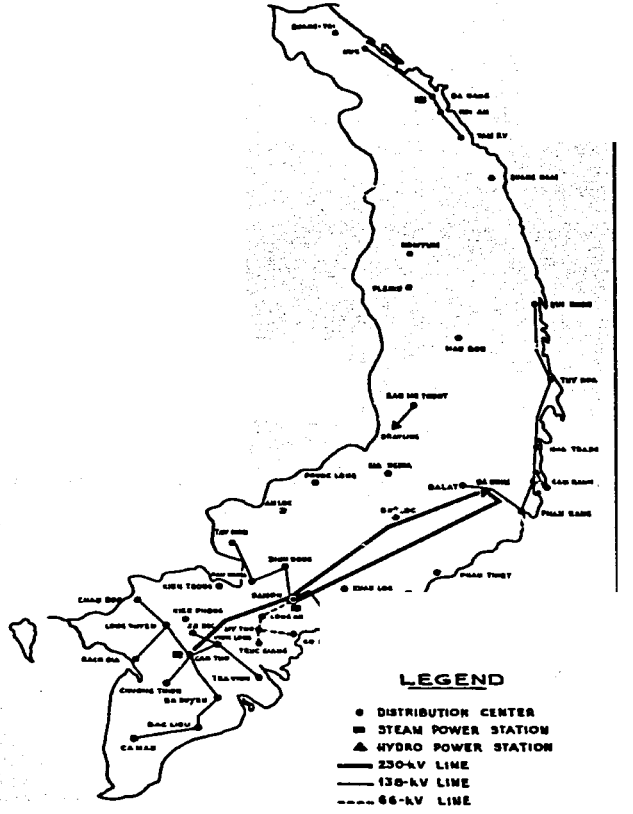


FIGURE I-4

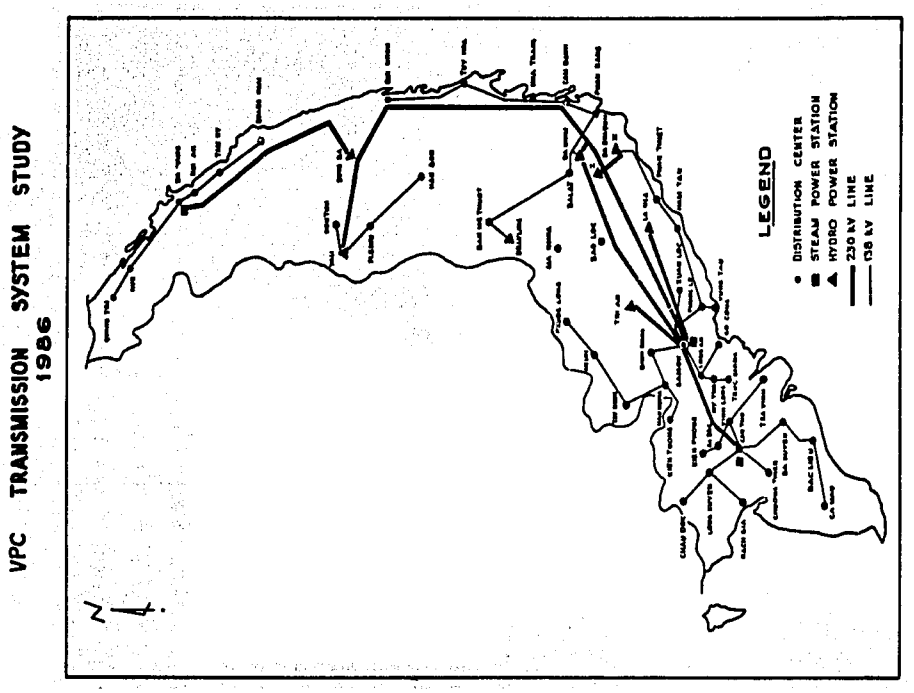


FIGURE I-6

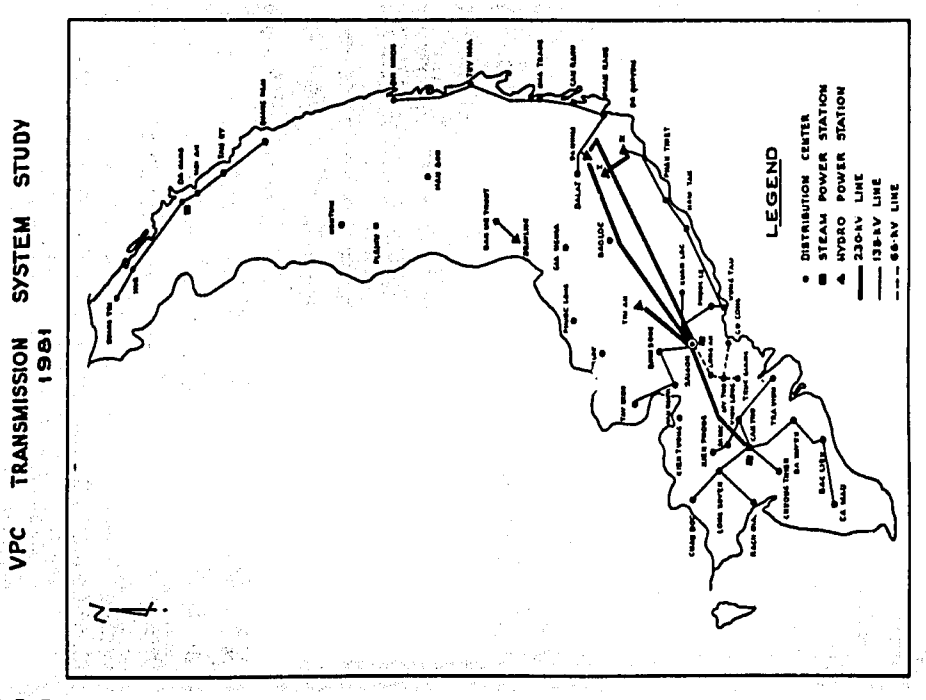


FIGURE I-5

FIGURE I-7

SCHEDULE OF PROVINCE CENTER TRANSFERS TO INTERCONNECTED SYSTEM

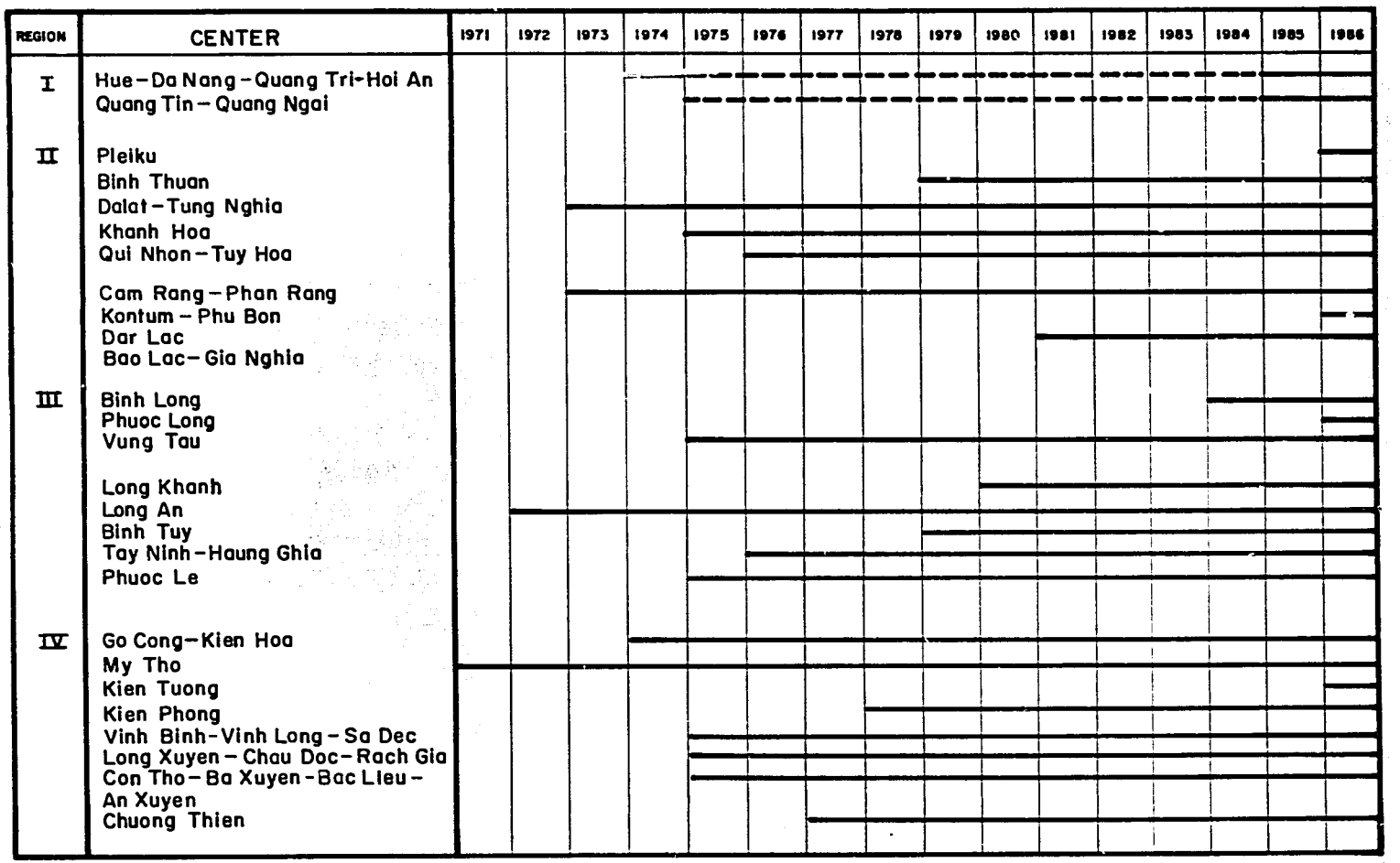


TABLE I-1

PLAN A

SOURCE AND DISPOSITION OF TOTAL FUNDS
FINANCIAL METHOD USING STOCK AND BOND SALES
US$ MILLION (VN$275/US$1)

Description	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Source of Funds															
1 Project Type Financing	32.8	66.0	59.9	65.7	65.6	64.0	65.6	60.5	Convertibility after 1979						
2 From Income	6.4	9.1	11.7	14.8	18.3	20.5	23.5	26.1	29.0	32.3	35.9	39.8	44.3	49.2	54.7
3 From Depreciation	7.9	9.9	11.8	13.5	17.1	19.8	22.6	26.2	28.3	33.2	32.8	32.4	35.6	39.3	42.8
4 From Stock Sales	7.4	17.9	14.6	16.8	16.3	1.4	6.9	–	–	–	–	–	–	–	–
5 From Bond Sales	–	–	–	–	–	–	–	–	61.4	33.8	45.9	57.2	45.0	61.5	34.6
Total	54.5	102.9	98.0	110.8	117.3	105.7	118.6	112.8	118.7	99.3	114.6	129.4	124.9	150.0	132.1
Disposition of Funds															
1 Major Construction	44.9	88.3	83.9	94.0	94.6	94.0	93.6	90.3	86.0	71.6	92.6	94.3	85.8	110.4	94.3
2 Other Construction & Working Capital	7.5	9.5	7.9	10.4	17.1	6.6	17.4	11.1	17.6	10.9	3.1	12.9	13.9	14.4	12.6
3 Payment on Domestic Debt	0.1	2.4	2.7	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.9	2.9	2.9	2.9	2.9
4 Payment on Foreign Debt	2.0	2.7	3.5	3.6	2.8	2.3	4.8	8.6	12.3	14.0	16.0	19.3	22.3	22.3	22.3
Total	54.5	102.9	98.0	110.8	117.3	105.7	118.6	112.8	118.7	99.3	114.6	129.4	124.9	150.0	132.1

TABLE I-1

TABLE I-2

PLAN A

VPC FOREIGN EXCHANGE CONVERTIBILITY REQUIREMENTS
US$ MILLION (275VN$/US$1)

Description	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Source of Foreign Exchange															
1 GVN Stock Purchase	7.4	17.9	14.6	16.8	16.3	1.4	6.9	–	–	–	–	–	–	–	–
2 VPC GVN Exchange	14.5	8.5	12.0	16.2	24.0	41.4	46.5	57.8	66.3	66.5	73.4	86.2	95.5	103.9	109.9
Total	21.9	26.4	26.6	33.0	40.3	42.8	53.4	57.8	66.3	66.5	73.4	86.2	95.5	103.9	109.9
Disposition of Foreign Exchange															
1 Fuel, General Plant, M & S, Etc.	17.9	19.7	16.0	18.8	23.2	22.5	26.9	24.0	25.6	21.5	23.8	30.4	34.0	36.6	37.5
2 Foreign Debt Service	4.0	6.7	10.6	14.2	17.1	20.3	26.5	33.8	40.7	45.0	49.6	55.8	61.5	67.3	72.4
Total	21.9	26.4	26.6	33.0	40.3	42.8	53.4	57.8	66.3	66.5	73.4	86.2	95.5	103.9	109.9

TABLE I-2

A financial plan for Plan A, continuing the method of financing now used by VPC, was prepared as shown in Table I–3. For purpose of comparison, Table I–1 shows Plan A financing and assumes that VPC could sell stock. The principal difference in the methods is that instead of selling stock, VPC borrows the necessary money. The interest rate used for borrowing (18 percent) is the lowest commercial rate available and is the figure at which VPC has borrowed on the commercial market. GVN could loan money to VPC at a lower interest rate which, in effect, would be a subsidy and would not give a true picture of VPC operated as a commercial enterprise.

A comparison of the two financing methods for Plan A is shown on Figure I–8. The gross income needed is approximately the same in each case, Rate reductions of about the same magnitude, over 40 percent in 15 years, could be made. However, the net income under the method with stock sales reaches almost US$55 million by 1986 compared to US$24 million in the other method.

The effect on the debt and equity position is shown on Figure I–9. If VPC continues on its present course, without sale of stock securities, its debt in 1986 will reach almost US$980 million whereas with stock sales, its debt would be only US$729 million. Its equity position under the stock sales method will be about US$500 million as compared with US$230 million. This means that the book value of the company to the stockholders is twice as much. Thus, by the purchase of US$82 million of stock, the owner's equity is increased by US$270 million.

The debt-equity ratio fluctuates through the years, but by 1986, debt is 55.4 percent and equity 44.6 percent which is a very satisfactory position for the company and which will assist substantially in helping qualify VPC in the international banking field.

The financial method proposed does not pretend to portray nor forecast the actual figures which will eventuate. For example, future inflation may not permit the rate reductions shown, but the real costs to the consumer for electric power will be relatively and progressively lower than the real costs of other commodities.

VPC REMOVING ILLEGAL TAPS FROM DISTRIBUTION LINES.

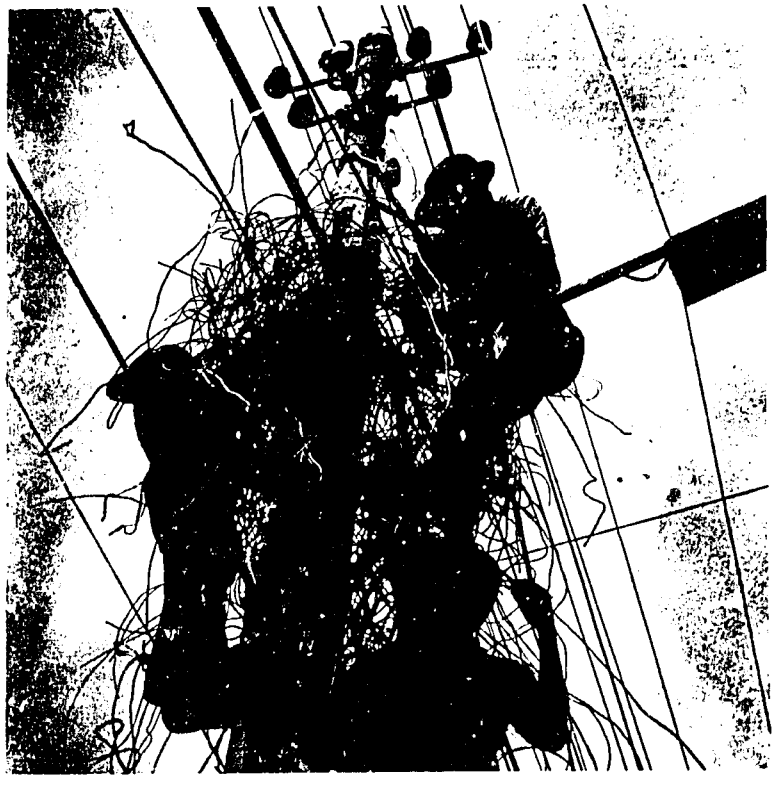


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TABLE I-3

PLAN A

SOURCE AND DISPOSITION OF TOTAL FUNDS
FINANCIAL METHOD USING PRESENT PRACTICE OF VPC CONTINUED
US$ MILLION (VN$275/US$1)

Description	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Source of Funds															
1 Project Type Financing	32.8	66.0	59.9	65.7	65.6	64.0	65.6	63.8	61.1	50.9	65.2	66.1	60.8	77.7	62.9
2 From Income	5.5	6.1	6.8	7.6	8.4	9.3	10.4	11.5	12.8	14.2	15.8	17.6	19.5	21.7	24.1
3 From Depreciation	7.9	9.9	11.8	13.5	17.1	19.8	22.6	26.2	28.3	33.2	32.8	32.4	35.6	39.3	42.8
4 From 18 percent Borrowing	8.3	21.3	21.0	26.5	30.1	18.0	26.3	18.9	25.0	10.8	11.1	24.2	21.3	27.7	22.6
Total	54.5	103.3	99.5	113.3	121.2	111.1	124.9	120.4	127.2	109.1	124.9	140.3	137.2	166.4	152.4
Disposition of Funds															
1 Major Construction	44.9	88.3	83.9	94.0	94.6	94.0	93.6	90.3	86.0	71.6	92.6	94.3	85.8	110.4	94.3
2 Other Construction & Working Capital	7.5	9.5	7.9	10.4	17.1	6.6	17.4	11.1	17.6	10.9	3.1	12.9	13.9	14.4	12.6
3 Payment on Domestic Debt	0.1	2.8	4.2	5.3	6.7	8.2	9.1	10.4	11.3	12.6	13.2	13.8	15.0	16.0	17.4
4 Payment on Foreign Debt	2.0	2.7	3.5	3.6	2.8	2.3	4.8	8.6	12.3	14.0	16.0	19.3	22.5	25.6	28.1
Total	54.5	103.3	99.5	113.3	121.2	111.1	124.9	120.4	127.2	109.1	124.9	140.3	137.2	166.4	152.4

FIGURE I-8

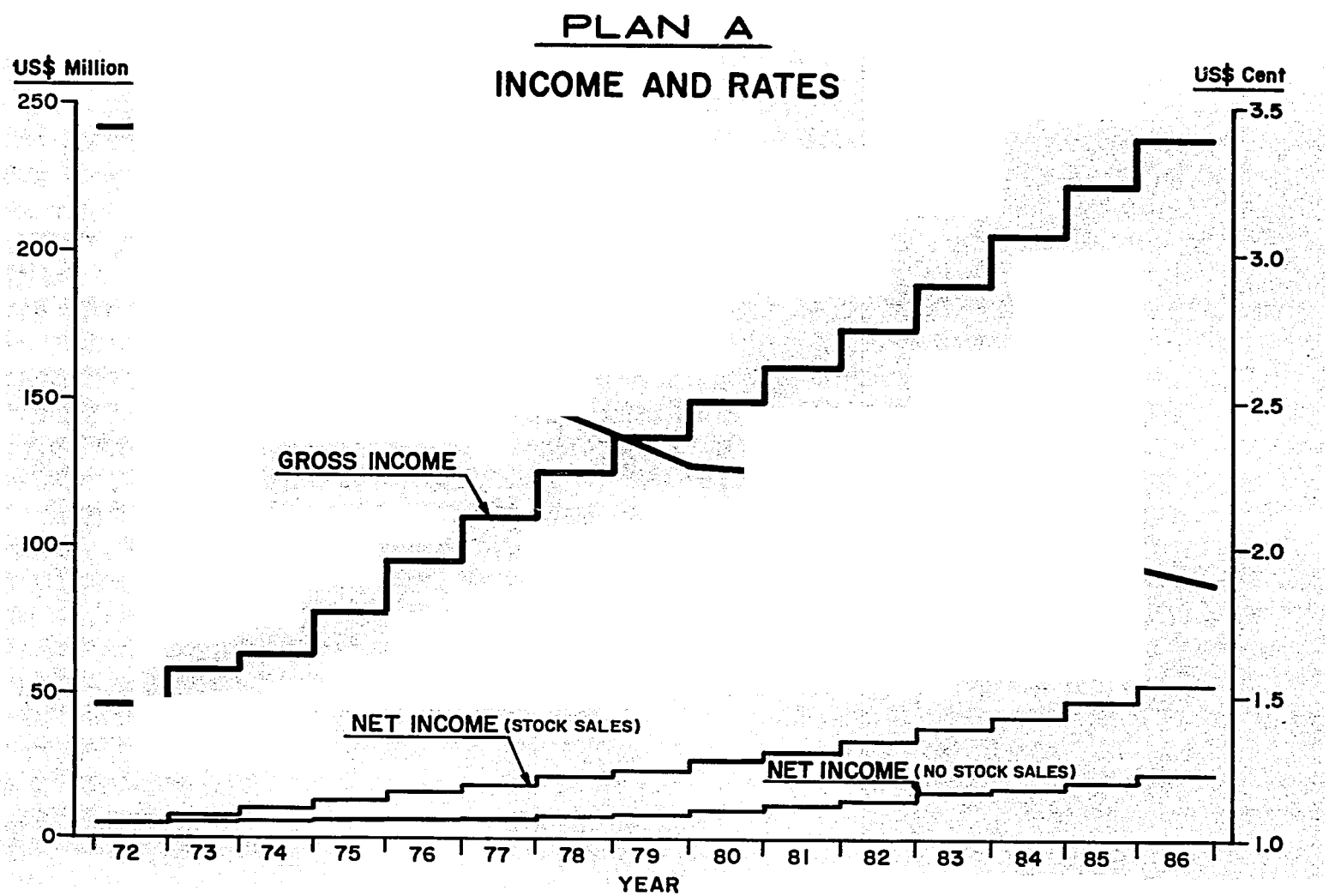
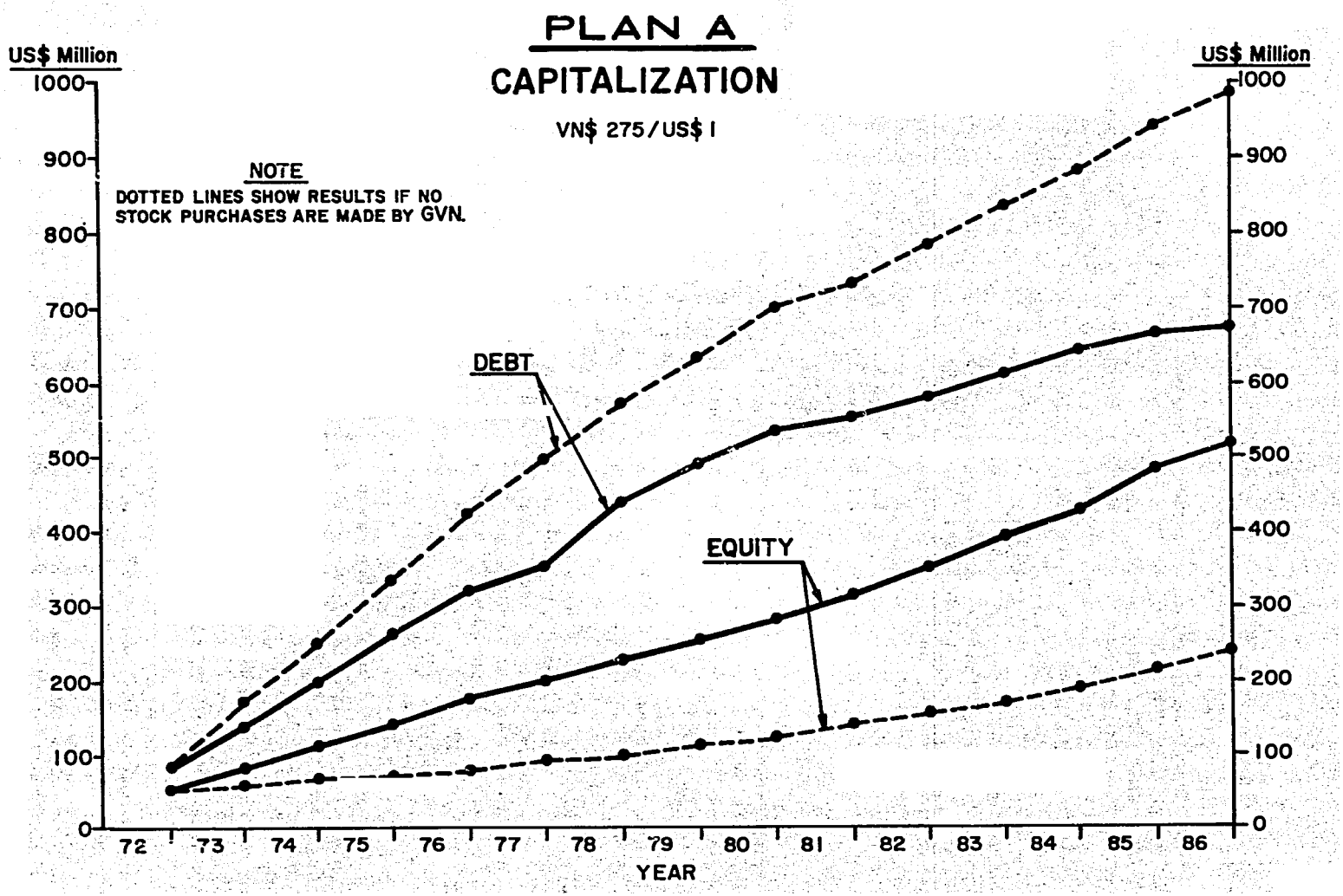

PLAN A
INCOME AND RATES
US$ Million
US$ Cent
250
200
150
100
50
0
3.5
3.0
2.5
2.0
1.5
1.0
GROSS INCOME
NET INCOME (STOCK SALES)
NET INCOME (NO STOCK SALES)
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
YEAR

FIGURE I-9


PLAN A
CAPITALIZATION
VN$ 275/US$ 1
US$ Million
US$ Million
NOTE
DOTTED LINES SHOW RESULTS IF NO STOCK PURCHASES ARE MADE BY GVN.
DEBT
EQUITY
1000
900
800
700
600
500
400
300
200
100
0
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
YEAR

45

SECTION I

CONCLUSIONS AND RECOMMENDATIONS

The total capacity from all sources in Vietnam in 1970 was 760.9 MW including VPC (272.9 MW); the Societe Indochinoise pour les Eaux et l'Electricite en Annam (SIPEA) (25.7 MW); industry (106 MW); the US military (325 MW); and miscellaneous sources (31.3 MW). The Saigon metropolitan area system peak for 1970 was 187 MW and in early 1971, 199.7 MW which can only be increased a nominal amount in 1971 due to a shortage of facilities. There is an estimated immediate potential load of 300 MW in the Saigon metropolitan area and 156 MW in the provinces for a total of 456 MW against an availability of 246 MW. In addition, many customers are receiving very poor service. (Section V)

The rates for power, particularly for industry, are very high and present a serious problem in the encouragement of industrial expansion. In many varieties of industry, studies indicate that self-contained power plants would be more economical than service from existing utilities. (Section II)

The lack of definitive plans for industry makes it difficult to provide other than a very rough estimate of future industrial power sales. VPC, in its five-year program, estimates industrial sales in 1975 at from 50 to 60 percent of total sales.[2] Assuming appropriate industrial rates, it may be assumed that industrial sales could increase from 50 to 60 percent in 1975, to 60 to 70 percent in 1986, or an average of from 55 to 65 percent, respectively. Industrial demands of about 300 MW in 1975 growing to 1560 MW in 1987 are indicated. (Section II)

It is recommended that VPC revise its rate structure to encourage the development of existing industries and the establishment of new industries. (Section IX)

The growth rate of VPC will be such that its needs for transformers, insulators, and meters will be large enough to support in-country assembly and manufacturing of these items with substantial savings in foreign exchange. It is recommended that VPC take such steps as may be appropriate to assist in establishing these industries. Further investigation may indicate other power-related manufacturing and assembly industries which should receive VPC support. (Section II)

Vietnam has very little fossil fuel resources. There is only one known coal deposit in Vietnam. It is small and the quality is inferior. It does not compare favorably with anthracite coal found in North Vietnam which was formally used in Vietnam. No oil or gas has yet been found and all fuel oil must be imported. No exploration has been made for uranium or other nuclear minerals. (Section III)

Vietnam is richly endowed with water resources and preliminary investigations indicate there may be over four million kilowatts of potential hydroelectric power. It is recommended that this potential be as fully exploited as possible. (Section III)

There is lack of sufficient hydrological information for most of the potential hydroelectric power sites in Vietnam. It is very important that stream flow gaging stations and weather recording stations be established and maintained on all streams and watersheds having potential hydroelectric possibilities. (Section III).

Investigations should be made to determine if the available record of stream flow and rainfall can be correlated satisfactorily by computer methods to develop synthesized stream flow data for each stream having potential power possibilities. (Section III)

In order to properly evaluate the availability of water and storage for power purposes, it is necessary to consider all other uses for water including irrigation, flood control, stream regulation, salt water intrusion, and other uses. It is recommended that GVN make a comprehensive investigation of all of the water resources of Vietnam and their potential development possibilities. (Section III)

The cost of multipurpose water use facilities should be allocated to the various uses served, such as flood control, irrigation, electric power, etc., in proportion to the benefits provided to each purpose. The cost of multipurpose facilities allocated to flood control or recreation, for example, should be underwritten by GVN as these are national benefits. The cost of multipurpose facilities allocated to irrigation should be underwritten either by the water user beneficiaries or by GVN so as to relieve VPC of having to bear costs not related to power

[2] VPC, *Power Requirement Forecast 1972–1976.* June 1971. All references to a VPC five-year program are to this report.

benefits. (Section III)

Adequate steps should be taken to preserve the forest and natural cover of watersheds in order to minimize the amount of sediment and bed-load material carried by streams during heavy runoff periods and thus prolong the useful life of storage reservoirs. (Section III)

When conditions permit, reconnaissance-type investigations should be made of the various potential hydro sites which have been cataloged but which have not been investigated except by desk studies made from available small scale maps. These preliminary investigations should make it possible to select the more promising projects to be investigated more thoroughly. (Section III)

Feasibility studies should be undertaken, as soon as security conditions will permit, of several of the more promising potential hydro projects. It is essential to have this information in order to select the projects to be constructed and to intelligently plan a long-range power development program. The long lead time required for the construction of large hydroelectric projects makes it essential that they be investigated well in advance of the time when the power will be needed. (Section III)

In general, low stream flows during protracted dry spells and the lack of large reservoir storage sites due to the steep terrain do not permit the total VPC power requirements to be supplied wholly from hydro sources. (Section III)

During an average water year, much of the load can be carried by the hydro plants in Vietnam when they are developed; but during protracted dry spells, there will be deficiency of energy and thermal support will be necessary. (Section III)

Irrigation and other needs will have an effect on the operation of the hydro plants and may have a limiting effect on power production. (Section III)

It is recommended that studies be made as to the possibilities of using energy from Mekong River storage projects, such as the proposed Sambor project in Cambodia, during dry spells on Vietnamese rivers with subsequent payback of energy under suitable terms when river flows are average or above. Although the development on the Mekong River may not be available for ten to fifteen years, continuance of close association of VPC engineers with the studies now being made by the Committee for the Coordination of Investigations of the Lower Mekong Basin (Mekong Committee) could be very valuable to VPC in many ways. Some of the tributary streams to the Mekong River rise in Vietnam and the water contributed from these streams should be considered as an asset. VPC should consider the opportunities and advantages to be gained by interconnections with a system of the size proposed for the Mekong development. Represented in the opportunity to become part of such a system are advantages in availability of large additional blocks of low-cost energy, improved diversity, strong backup to override sudden loss of a large unit, diversity of catchment basins, reduced spinning reserve requirements, backup for routine maintenance operation, pooling of resources, reserve for contingencies occasioned by natural or other disasters, and scheduling of generation for best overall efficiency and economy. (Section III)

The advantages of developing water resource projects are many. Cost of operation is low compared to thermal plants and fuel imports are not required with a possible net saving in foreign exchange requirements. Such projects frequently can be designed to include space for future additional generating units at a nominal cost. In many cases, benefits in addition to power, such as irrigation, recreation, and flood control, may become available. Such projects develop the resources of Vietnam and offer much more employment opportunities. They require large amounts of capital initially but only relatively small amounts of money for operation and maintenance. (Section III)

Load estimates based on extrapolation methods are impractical because of the large pent-up demand in relation to the load served. Therefore, a method was used which is based on population, per capita income, and GNP projections. The results of load curves based on eight, seven, and five percent increases in the annual growth of the GNP were prepared. These were later compared to historical load curves for the developing countries of Korea, Taiwan, and Thailand; and it was found that the load projection based on a seven percent annual growth in GNP gave good correlation. (Section V)

With respect to the economic future of Vietnam, the JGD report concludes that Vietnam can achieve economic independence without continuing dependence or concessionary aid from overseas; that this objective can be achieved within a period of ten years after the war comes to an end; and that during this ten-year period, an annual growth of seven percent in the GNP can

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reasonably be assumed depending on the policies and determination of the government. (Section II)

It is recommended that the load projection based on a seven percent annual rate of growth of GNP be used for initial planning purposes and that it be reviewed annually for the next 15-year period and modifications made as may be warranted by changed conditions or availability of new information. On the basis of a seven percent annual growth in GNP, the 1986 peak load is estimated at 2680 MW of which 1700 MW is in the Saigon area and 980 MW in the provinces. From 1986 to the year 2000, it is reasonable to suppose that the total load could grow fourfold to nearly 11 000 MW. (Section II)

In order to have more data available for future load estimating, it is recommended that information be accumulated on various kilowatthour uses for three or four basic types of residences for small and large commercial establishments and the different governmental uses, such as water and irrigation pumping, public buildings, and street lighting. Data on existing and proposed industrial activities and population trends should also be collected as well as any other pertinent information. This should be a continuing activity. Continuing analysis of all the data should be done for use in system planning, operations, and other company activities. (Section V)

The Scope of Work requested consideration of two plans, and a third plan, intermediate between the two plans, was considered as a consequence of these two plans. These were designated as "B", "C", and "A", respectively. The third plan was designated as Plan A since it is the plan which is recommended for initial planning due to the smaller amounts of capital funds required. It is recommended, however, that as time goes on and if availability of funds permit, a shift be made to Plan C. Plan A requires a total expenditure over the 15-year period of US$1277 million for generation, transmission, and distribution development. Foreign exchange in the amount of US$895 million represents 70 percent of the total, and local costs amount to 30 percent or US$382 million. Plan A, overall, requires an investment of approximately 16 percent or US$180 million more than Plan B and approximately 8 percent or US$108 million less than Plan C. (Section VI)

It is also recommended as a matter of urgent consideration that the long-range plan be reviewed each year for the succeeding 15-year period and indicated desirable adjustments made. The plan proposed is not to be considered as a "blueprint" for the future, but rather as a planning vehicle to be constantly reworked in the light of new data and new developments. This will require a high degree of competence and attention by system planners. (Section VI)

The addition and expansion of diversified industries should improve annual load factors and it is assumed that the load factors will increase from 60 percent in 1972 to 65 percent in 1986. Load factors should be reviewed as part of system planning since a change in load factor could affect the timing of installation and the amount of new capacity required. (Section VI)

The basic criterion used in planning additions to generating capacity was to utilize potential hydroelectric projects to the maximum extent feasible. In this program, some steam electric plants are recommended. Their purpose is to provide for a supply of energy during periods when low stream flows curtail the output of the hydroelectric plants. A comprehensive engineering analysis should be undertaken to incorporate design features that will provide the lowest cost energy compatible with the capital funds available. (Section VI)

Some of the factors involved in the early development of hydro projects in Vietnam include the length of time required for field investigations due to the uncertainty with respect to security conditions. Thermal generation can be installed much more quickly and, in the early years, offers the only practical alternative in meeting the pent-up loads as soon as possible. (Section III)

Site selections of large thermal plants require extensive investigation and study. Plants should be located near the load center consistent with cooling water needs and problems of air and water pollution. Design should include consideration of high stacks or other devices to minimize air pollution. (Section III)

Hydro projects should be evaluated on the assumption that the output delivered to load centers should not exceed the cost of an equivalent amount of power and energy produced by the lowest cost alternative. Cost of oil to VPC in mid–1971 delivered at dockside and without domestic taxes was about US$0.36 per million Btu. Oil prices have since increased and the effect on hydro projects is to make them more economically attractive. (Section III)

US grants to GVN for use by VPC require interest payments by VPC to GVN of about six

percent. Some funds have been made available to VPC at three percent interest. International banks are loaning money at rates of six percent and less. VPC has no foreign exchange authority and all conversions for VPC must be made by GVN. GVN guarantees payment of interest and principal, and it is assumed that this will continue for 15 years or until VPC has an acceptable credit rating enabling it to earn favorable interest rates. On this basis, six percent interest has been used for cost of money for construction purposes of hydro and thermal plants and transmission and distribution. In cases where VPC borrows money in place of selling stock, a commercial interest rate of 18 percent has been used. (Section III)

The following potential hydroelectric projects appear to be economic and are included in the order shown in the 15-year generation program subject to further review when security conditions permit field investigations. (Section III)

Project	Installed Capacity kW
Drayling	12 000
Da Nhim Extension	106 000
Da Quayon 1, Stage 1	270 000
Da Quayon 1, Stage 2	270 000
Da Quayon 2	100 000
Tri An	240 000
La Nga, Stage 1	90 000
Song Ba	150 000
Yali Falls	200 000

It is recommended that the General Motors (GM) diesel units now providing interim power for the Saigon metropolitan area be programmed for a progressive relocation to Da Nang where they would continue to supply interim power until new capacity at Da Nang can be economically developed. There is adequate diesel capacity presently installed, under construction, or financially committed to provide for the small isolated loads in the provinces for the next 15 years. The Da Nhim Extension project should be constructed as soon as the necessary financing can be arranged. Final plans should be prepared for the Da Quayon project so that its construction can be started as soon as possible. Investigations should be started on the Tri An project as soon as the security situation will permit and final plans prepared in order that construction can be started in time to meet the loads. (Section VI)

Construction of the Drayling hydroelectric power plant should be started as soon as the security situation will permit and financing can be arranged. (Section VI)

The second 33-MW steam electric unit proposed for Can Tho is not recommended. A more economical program is to construct a 230-kV line from Saigon to Can Tho to supply the delta area load from less costly power originating at hydro and larger thermal plants, and one of the thermal units (125 MW) could be located at Can Tho instead of in Saigon, if desired. (Section VI)

Routine maintenance schedules and practices should be constantly reviewed and updated. A long-range maintenance program should be developed to assure an adequate supply of spare parts as well as parts necessary for breakdown or unscheduled maintenance. (Section VI)

It was requested that a recommendation be made for the disposition of the considerable 60-cycle diesel generating equipment used by the military forces. The frequency of VPC is 50 cycle. Conversion of the generators to VPC's frequency is not practical and they are not needed to supply small isolated loads. Discussions on this subject with military personnel revealed that it is the plan to send most of the units back to the US. (Section VI)

Development of a substantial bulk power transmission system is required to transport energy generated at steam and hydroelectric plants to the main interconnected loads. The existing 257-km, 230-kV transmission line will grow into a system of 1375 km of 230-kV lines which will represent an investment of US$92 million by 1986. This system should be developed in step with load growth and generation availability. Expenditures in the early years for transmission lines will be large, but later, the financial burden for this purpose will be reduced as the 230-kV system becomes more developed. Over the 15-year period, this system, together with the proposed subtransmission systems, will result in having over 97 percent of the total Vietnam projected load on the interconnected system. The approximate cost for these subtransmission systems is US$55 million for extension of 2000 km of wood pole lines and construction of 47 distribution substations. (Section VI)

The system can be developed by initially dividing Vietnam into four areas that can be economically integrated electrically. These include the Saigon metropolitan area, the Da Nang–Hue area, the Dalat–Cam Ranh–Phan Rang area, and

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the Can Tho area. These areas are interconnected first by rehabilitation of the Da Nhim–Saigon 230–kV line, next by construction of a 230–kV line from Saigon to Can Tho, and finally by connecting the Da Nang–Hue area into the basic system. (Section VI)

It is recommended as an important part of engineering and design plans for any of the proposed circuits that a thorough analysis be made prior to implementation or commitment of any work. Should additional capacity be required in any of the circuits, the application of series compensators should be considered. (Section VI)

Establishment of a 230–kV loop around the Saigon metropolitan area is recommended to provide adequately for distribution of the power from the generating plants. The recent study by Sanderson & Porter, Inc., for the reinforcement and expansion of the transmission and distribution systems to serve increased loads in the Saigon–Cholon area has been reviewed and adopted in large measure as a basis for the longer range plan required for this report.[3] Transmission plans should be reviewed and up-dated periodically to keep abreast of needs and developments of the art. (Section VI)

The 66–kV voltage presently used in the Saigon–Cholon area can be expanded and reinforced as needed to take care of increasing loads. This voltage level may also be undergrounded expeditiously where rights-of-way for overhead extension in congested areas cannot be obtained. Additional substations will be required for reinforcement as loads grow and to provide service for new development in the expanding metropolitan area. (Section VI)

Province center loads now served by isolated high-cost diesel generation should be served from the central system when it becomes economic to do so. An orderly program of extending subtransmission lines to gather these centers should be developed. (Section VI)

Subtransmission at 138 kV to supply substations at province centers and other distribution centers outside the Saigon 230–kV loop is recommended because of the distances involved and the magnitude of anticipated loads. An opportunity is available now to standardize on 138–kV supply to all distribution substations outside the Saigon area. This will make it possible to realize the full normal life of pole lines and transformers. (Section VI)

Although much of the distribution is inadequate, there is an overall comfortable position in substation capacity due to the large amount of diesel generation which inputs directly to the distribution lines. All secondaries are three-phase. Long secondary runs, coupled with small conductors both in main line and in the service loops, appear to be chiefly responsible for the widespread low-voltage conditions. The problem is that the high cost of the cabine structure requires that it house a large transformer which, in turn, must serve long secondary runs to pick up sufficient load to justify the overall investment. It is recommended that the use of cabines be discontinued. (Section VI)

In the provinces, local managers have a very good understanding of their systems. Each has definite plans for extension of the distribution systems. (Section VI)

An immediate problem in the less secure rural areas outside the province center or city is that the income per capita is so low that many of the people cannot afford electrification until they have had an opportunity to restore their land and earning power. However, in the province centers and cities there is a large pent-up demand. (Section VI)

The existing three cooperatives operate distribution systems and purchase their power requirements from VPC. They are financed by loans fron GVN on the basis of a grant made by the US Agency for International Development (USAID). Before any expansion of the existing rural electric cooperatives or the forming of additional cooperatives can take place, additional funds must be made available for loans to the cooperatives. (Section VI)

A long-range distribution plan for VPC or any power company must be directed toward the goal of delivery of energy in a safe, reliable, and economical manner from the subtransmission system to the ultimate consumers. VPC will have to constantly upgrade service quality to meet increasingly critical standards imposed by an ever more aware public. VPC must build boldly, keeping in mind that seldom has an electric utility system been overbuilt. The present system represents only a rather small increment in facilities and investment of the system which will be required to meet the needs of the 1980's and later. Today's system, then, should not necessarily dictate perpetuation in kind,

[3]Sanderson & Porter, Inc. *Transmission and Distribution Program for Vietnam Power Company Saigon–Cholon Area Development*, May 1971. Prepared for USAID under Contract AID/vn–88.

particularly if it has been found to have distinct disadvantages. (Section VI)

The present system of underground primary cables, cabine housing of large transformers, and long runs of small secondaries, expensive and inadequate in many instances for present loads, will just not do the job in meeting the demands of tomorrow. Expansion of this massive, inflexible system with more cabines at closer and closer intervals to satisfy new and growing loads is inconceivable, cost-wise and space-wise. (Section VI)

VPC has already recognized that less expensive, less complicated construction must be utilized if their program to overtake the pent-up demand and keep abreast of current needs through maintenance of adequate distribution systems is to be successful. (Section VI)

The voltage level of 15 kV has been in use by VPC and is quite suitable for continuation as the standard for primary in the metropolitan area. The recommendation to "wye" this system as proposed by Sanderson & Porter is endorsed. (Section VI)

It is suggested that a master plan be developed attempting to look forward ten years or more and that it designate substation locations and the main feeder routes to be developed. In selecting a substation site, it is important to overall economy and best distribution that a location at or near the load centroid of the area to be served is chosen. It is suggested that in lieu of a switching arrangement internal to the substation, consideration be given to a less expensive external tie through a gang-operated air break switch to an adjacent feeder from the same substation at or near the cable pole. (Section VI)

The present 15–kV distribution should be converted to a four-wire 15/8.7–kV common neutral system. All new primary distribution should be the same and neutral extensions should be used whenever possible. (Section VI)

Overhead wood pole construction should be used to the greatest extent possible for reinforcement and development of distribution systems. Complete specifications for quality of timber, preservative, and treatment should be developed and made available to the inspectors. (Section VI)

A master plan should be prepared for 15–kV distribution expansion to be used as a guide for daily engineering of work orders and maintained on a current basis. (Section VI)

Conductor sizing, particularly in the feeder mains, should be studied in relation to the economic aspects relating to cost of losses. It is usually the case that a much larger conductor than is normally required by thermal and voltage drop limitations can be justified when capacity and energy costs of losses are evaluated. (Section VI)

VPC is giving consideration to the use of sectionalizers, reclosers, and fuses for isolating faults in the 15–kV feeders. These devices are effective and perform well when properly coordinated and maintained. It is suggested, however, for the early years at least, a less sophisticated system utilizing a substation breaker or recloser and fuse combination be evaluated. (Section VI)

Voltage regulation and var supply can be improved by installing switched capacitors and voltage regulators. Secondary lengths should be designed to prevent excessive voltage drop. Periodic check of voltage conditions at the end of secondary runs at consumers service entrances should be made. (Section VI)

It is recommended that a program be developed for checking the loading of distribution transformers by using a printout from the billing process. Before this is developed, checks can be made of transformer loading by using portable instruments. Many distribution transformers are now actually metered. These meters are recommended for removal. Hence, the recommended program will be needed in the future. (Section VI)

Utilization of single-phase transformers, connected phase-to-neutral, will simplify primary extensions and reduce costs where three-phase services are not required. This should also prove a distinct aid in extending primary into alleys and narrow ways for the purpose of assisting present inadequate secondaries where single-phase will suffice. Replacement of the old 6.6–kV system with new 15 kV over a period of time will serve to improve operating records in addition to substantially reinforcing capacity in areas of high-load density. (Section VI)

The size of distribution transformer installations should be adequate for reasonable load growth so as to avoid early replacement. It is recommended that sizes of distribution transformers be standardized and intermediate sizes eliminated in order to reduce inventory and handling costs. (Section VI)

It is recommended that capacitor installations be utilized on the new feeders in a manner not only to supply so far as possible the reactive requirements near the loads but to assist in

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maintenance of proper voltage levels. An annual program of capacitor additions in a ratio related to the increased system load is recommended. (Section VI)

Comprehensive construction standards for 15–kV distribution should be developed as a necessary tool for engineering and field forces. Review mapping, design, and construction standards and specifications periodically to provide for the latest developments in distribution practices and to provide for economical and adequate construction. (Section VI)

Secondary voltage street light circuits should be eliminated, and the use of individually controlled street lights connected to the secondary distribution system should be developed. (Section VI)

There is a great need for improved street lighting for safety and other reasons in much of the city. Accomplishment of this goal will be a most significant item in making possible a cleanup of the overhead pole lines. Development of an overall plan for street lighting, with proper attention to lighting levels appropriate for various classes of streets and traffic situations, will assist the city officials responsible for authorizing additional lighting in making their decisions. VPC will also benefit from the standpoint of being able to coordinate new construction work with future street lighting requirements (Section VI).

Main feeder routes to provide greatest freedom from hazards of overhanging trees, traffic, etc., should be selected. Direct pole-mounted transformers should be used in lieu of pole platforms for cost and appearance reasons. (Section VI)

Single-phase secondary should be developed to save costs in those areas where three phase is not required. Triplexed or quadruplexed conductors should be extended for improved appearance and better performance of secondaries. Future concentrations of load which may dictate underground systems, including networks in certain areas, should also be considered. (Section VI)

Joint construction by VPC, communication utilities, and the city would effect overall saving in pole line costs and make a substantial contribution to improved appearance. Careful attention must be given to appearance and placement of overhead facilities utilizing designs harmonious with the character of routes traversed. (Section VI)

Plans and additional details for implementing reinforcement and expansion of the distribution system to a capability of 450–500 MW are now under study by Sanderson & Porter. A continuing distribution expansion on an orderly basis in keeping with load growth will be necessary to provide service to all applicants. The program outlined by Sanderson & Porter has been thoroughly reviewed and the principles advanced appear reasonable and suitable for extrapolation to meet the needs of much greater load levels expected in the future. (Section VI)

In harmony with the subtransmission and substation expansion program, it will be necessary in the 15-year period to construct at a similar rate distribution feeders, local primary and secondary lines, and distribution transformer stations and install the ultimate service connections for an estimated additional 388 000 households plus commercial and industrial loads. A minimum capacity of 160 new 15–kV feeders with all appurtenances will be required. (Section VI)

In order to eliminate the practices of a metered customer supplying power to subcustomers and the outright theft of current by unmetered taps, an aggressive program is required. First, a definite procedure on the part of VPC is required to have the subletting of power by a customer forbidden as a condition of furnishing service. Secondly, and coincident with the above, it will be necessary for VPC to be in a position to furnish direct service to all customers. (Section VI)

It is recommended that the authority necessary to forbid subletting of power be specifically conferred upon by VPC by GVN, perhaps as a provision in a new franchise agreement. (Section VI)

Looking to long-range improvements, the adoption and enforcement by governmental authorities of building codes covering new construction which would include restrictions of overhang into public rights-of-way and also require minimum setback of buildings from side and rear lot lines are recommended. The clear lanes thus reserved would ensure not only ready utility access but improve fire safety. (Section VI)

It is important at the outset of the development program visualized in this study that comprehensive construction standards be developed and adhered to, particularly in the distribution system where there is a very large volume of repetitive operations. The uniformity of construction resulting will simplify operation and maintenance functions and contribute to

overall improved appearance of the system. (Section VI)

Inasmuch as a large amount of the rural area may be served by rural electric cooperatives under the terms of the Agreement between the Director of USAID and the Office of the Prime Minister, it is recommended that there be close coordination between the design engineers of VPC and the cooperatives to eliminate any duplications and to establish acceptable wholesale power delivery points.[4] The work is simplified in that both VPC and the cooperatives have standardized on 8.7/15–kV for the distribution voltage. (Section VI)

In accordance with the above Agreement, it is recommended that VPC furnish the power to the cooperatives either from province centers or by installing and operating diesel-driven generators until bulk power can be made available from the interconnected system. If a cooperative should finance a generating unit, VPC should be required to purchase the unit when it is in a position to give satisfactory central system electric service. To assure that the cooperative will benefit from the lowest cost power available, NUC should be required to make a study and, if it finds that VPC can provide more economical power, it should issue an order requiring VPC to connect the cooperative to its system. (Section VI)

Consideration should be given to minimizing pollution from thermal plants. The use of tall stacks can assist greatly in minimizing objectionable air pollution and fallout on the ground. Most of the fly ash in the furnace stack can be removed from stack gases by mechancial separation or electrostatic precipitators. Future large thermal generating stations in the Saigon area should be selected so as to avoid, as much as practicable, superimposing the pollutants from the station on an already seriously polluted area. Furthermore, proper steps should be taken to minimize the emission of harmful pollutants from these plants. (Section VI)

Normally, hydro plants have no environmental problems. Hydro plants, properly operated, usually tend to improve stream flow conditions, reduce floods, and provide recreational benefits. (Section VI)

[4]USAID Project Agreement, *Rural Electric Cooperatives (Terminate Construction)*, Project No. 730–11–220–357, Agreement No. 71–019, dated September 14, 1971 between USAID and the Office of the Prime Minister, GVN. All reference to a USAID Agreement concerning rural cooperatives is to this agreement.

Utilities worldwide have found the appearance of overhead construction to be a matter of serious public concern and, therefore, worthy of attention. (Section VI)

It is recommended that VPC exercise the right to purchase the SIPEA property when the franchise expires. In order to make the change in operation as smooth as possible, VPC should maintain a close relationship with the SIPEA operating personnel. (Section VI)

On June 1, 1970, VPC adopted the classification of accounts recommended by the China Power Mission (CPM). It is now recommended that the numbering of the few asset accounts at variance with the Federal Power Commission (FPC) Uniform System of Accounts be changed to conform with the FPC system. The primary purpose of using a uniform system of accounts is that a lending institution anywhere can expect to find similar treatment of the various accounts regardless of what utility is being examined. (Section VII)

VPC has an abundance of operating detail both for the Saigon–Cholon area and for the provinces, but it lacks a formal budget procedure and this information is not as useful as it might otherwise be. VPC's reporting of revenues has not been in accordance with the FPC Uniform System of Accounts and should be changed. (Section VII)

Another deficiency in proper accounting procedures occurs in VPC's present billing practices. Beginning in May, 1969, the rate for air conditioning was made the same as the rate for lighting. However, although the rates for these two services are identical including the same taxes, VPC is still reading the two separate meters and rendering two separate bills to customers having both lighting and air conditioning service. This deficiency must be corrected before VPC can accumulate the necessary proper bill analyses required for proper rate design. (Section VII)

It is believed that a more factual statement of plant in service, required for proper rate design, would be obtained by revaluing all plant in service to the up-dated exchange rate. However, such a re-evaluation would be a very large task and because of the large construction program included in this study, the omission of such re-evaluation can have only minimal effects on the financial programs proposed. A work order system is recommended for use in recording plant to be installed. If this is done, future plant records will be accurate; the old plant will be fully depreciated over the next ten years and, in

the meantime, such old plant as is not depreciated will be dwarfed by the large additions made year by year. In the US, depreciation rates, like electric service rates, are subject to regulation by a public utility commission, and over the years, fairly uniform schedules have been established. (Section VII)

VPC now uses depreciation rates averaging about ten percent per year. The value of the old plant will be a very small fraction of the value of the proposed construction program, and it is recommended that present VPC depreciation rates be continued for the old plant. For plant added after January 1, 1972, it is recommended that depreciation rates averaging about 3.5 percent be used. (Section VII)

It is the present practice of VPC to charge interest during construction to operations. This is acceptable, at least for the present, since such charges do not produce funds for the cash flow. Charging this interest to expense reduces the income tax liability. However, it is the more usual practice to charge interest during construction to the capital cost of the project. In preparing the 15-year forecast, interest is shown as being charged to expense. However, it is recommended that VPC review this matter from time to time taking into account the resulting effect on net income, income taxes, and the rate base. It may, at some future date, be desirable to capitalize interest during construction. (Section VII)

As construction work in progress increases, the interest on the borrowings for construction will become of increasing importance. Since interest rates will fluctuate and since composite or individual rates require considerable accounting work, it is recommended that the company use an arbitrary rate. The rate used should approximate the composite rate in effect at the beginning of the year. The arbitrary rate should be reviewed each year and, if deemed advisable, changed. (Section VII)

Financing of expansion programs of privately owned utilities is accomplished, in general, partly through the use of internal funds and partly through external funds. The internal funds come principally from the annual provision for depreciation and to a lesser extent from retained net earnings. The amount of such funds would depend on established policy with regard to depreciation, the profitability of the company's operations, and on company policy with regard to the percentage of net income that is paid out to the company's owners, i.e., the shareholders. The additional capital required over and above what can be supplied from internal sources must be obtained from external sources. In most cases, this would involve the sale to the public of securities, such as mortgage bonds, preferred stock, or common stock. (Section VIII)

A fundamental aspect of US practice is that the capital structure keeps growing year after year. This is true of both the equity and debt portions of the structure. Although debt capital is usually obtained for a fixed period of years, it is normally retired when it matures through the sale of another series of bonds. The practice of amortizing the load during its term is unusual. The consumer, under US practice, actually pays for a substantial portion of the total cost of new facilities that are added each year. The consumer does this by bearing, in the price he pays for service, the costs of depreciation, i.e., the actual cost of plant consumed in providing service to him plus the net profit on the investment in such plant. If the depreciation as charged has a reasonable relationship to the loss in value of the plant needed to serve him and if the total net profit taken on such plant is reasonable, the consumer is not unfairly burdened. This method of financing is ultimately recommended in the financial program set forth in this report. (Section VIII)

The financing of VPC is governed by four conditions:

1. Until there is free convertibility of internally generated funds and marketability for VPC securities, borrowing of funds is limited to project financing.
2. GVN is the only source of additional equity funds.
3. Bank borrowing is at very high rates and should not be considered except for serious emergencies.
4. No matter how much money is generated internally by VPC, it can only be used internationally when converted by GVN into international funds. (Section VIII)

The primary financial problem involved in building an adequate power system in Vietnam relates to the large amounts of foreign exchange that will be needed. In aggregate, the plan developed will, in addition to foreign exchange obtained from project financing, require foreign exchange increasing from US$21.9 million in 1972 to US$109.9 million in 1986, or a total of US$903.9 million for Plan A for the 15-year period. However, considering the similar situations initially facing Taiwan and Korea and

their subsequent success, it is entirely possible that Vietnam will also surmount its problem. Considering GVN's presently limited amount of foreign exchange, it appears that GVN will need a considerable amount of assistance in the form of grants of foreign funds that can be loaned to VPC with interest and principal repayments made to GVN in domestic funds. (Section VIII)

The general objective in the financing programs shown in the report is to put VPC on a footing similar to other electric utilities. This can only finally be accomplished after Vietnam has free convertibility of its currency. An important goal is that VPC should have a reasonable capitalization ratio of about 60 percent debt and 40 percent equity. Under the proposed financing plan, VPC reaches this ratio in 1983 or 1984 depending on the construction plan and could presumably pay dividends beginning at that time and maintain the 60–40 debt-equity ratio. However, doing so would increase bond requirements and reduce allowable net income during this period. It has, therefore, been assumed that VPC would not pay dividends but permit the equity to grow through retained earnings. (Section VIII)

For comparative purposes, a financing program for Plan A has also been included where GVN does not purchase any additional stock, the required external funds being borrowed at a commercial rate of 18 percent with no subsidy from GVN. If GVN does not purchase additional stock, VPC's debt-equity ratio would exceed 80–20 for most of the 15-year period. It is, therefore, obvious that GVN must provide the necessary additional equity through purchase of stock if VPC is going to be able to realize an approximate 60-40 debt-equity ratio. (Section VIII)

The Commonwealth Associates, Inc., Management Services Team (MST) devoted a great deal of attention to the development of a useful computer department in VPC. The discussions, conclusions and recommendations in their report form a basis for recommendations made in this report concerning the development of a computer department in VPC.[5] (Section VIII)

In matters involving finance and accounting, the Data Processing Center (DPC) makes specialized computer runs on an irregular basis. There are no records, flow charts, or scheduling of these runs. The need exists to analyze these and establish regular monthly schedules to include preparation of financial statements on an up-to-date basis. (Section VIII)

Jobs are not scheduled on a monthly basis. A monthly schedule should be prepared showing jobs allocated to machines in order to better plan the processing of new jobs. (Section VIII)

DPC is now operating under the handicaps of insufficient floor space, inadequate equipment, and lack of trained personnel. Each of these problem areas is mutually dependent on the others. They all must be solved concurrently. (Section VIII)

The space problem is most critical. Cards and forms are ordered in large quantities to reduce costs. They are stored along the walls and on the tops of cabinets and create a fire and safety hazard and reduce the efficiency of the air-conditioning system which, in turn, affects the operation of the central processing unit. In addition, the amount of office space is inadequate. Any increase in personnel can barely be accommodated because there is little available space for a desk. (Section VIII).

The present International Business Machines (IBM) 360/20 system is inadequate because the programming language is not business oriented, the speed of the printer is too slow, and there are no tape drives. The Report Program Generator (RPG) language generates report formats only and is cumbersome to use. The generally accepted language for business is Common Business Oriented Language (COBOL) and for engineering is Formula Translation (FORTRAN). (Section VIII)

The present organization is seriously lacking in well-trained, academically qualified and experienced personnel. About six months ago the first college trained computer systems specialist was hired. There is a need for at least five more. (Section VIII)

It is recommended that the 370/135 IBM system be procured in accordance with the recommendation of MST. The slower 360/40 system will be inadequate in four or five years. (Section VIII)

Rates charged customers by VPC are on a flat-rate basis plus additional charges for taxes and assessments. There are three general rate levels: lighting, low-voltage power and medium voltage. By means of a complicated formula, the

[5]Commonwealth Associates, Inc., MST, *Final Report to Vietnam Power Company and Agency for International Development.* Volumes I, II, and III. Prepared under Contract No. AID/vn–14. August 1971. All references to a MST report are from these volumes.

three rate levels are determined so that the low-voltage power is 0.9 times the lighting rate and the medium-voltage rate is 0.8 times the lighting rate. MST made a thorough study of VPC's rates and recommended an ultimate tariff limiting all metered service to three basic block type rates: monophase lighting and power, triphase lighting and power and medium-voltage power and that, later, block-type rates for each of these services would be adopted. It also recommended the elimination of the complicated formula. NPS concurs in the conclusion of MST but believes that the block-type rates should not be adopted at this time. When overall rate levels are adjusted, block-type rates based on a cost-to-service basis should be established to promote additional sales. In the meantime, rates should be determined based on actual relationship of revenues, expenses, and net plant in service as shown by actual operation. (Section IX)

Users having lighting and air-conditioning are billed at the same rate but have two meters and receive two bills. They can and should be served with one meter. Some 5000 additional customers having lighting and low-voltage power now served through two or more meters should also be served by one meter when a combined rate has been established. It is recommended that VPC begin to accumulate data based on the principle that all service to a single customer at a single location will be served through a single meter so that the necessary data required for proper rate design will be available when the time comes to adopt block-type rates. It is also recommended that VPC accumulate the necessary detailed statistics on net plant in service, production, transmission and distribution, and detailed operating and maintenance expenses, together with data on class load curves, in order to properly allocate plant and expenses to customer costs, facility costs, and energy costs, for cost-to-service studies. (Section IX)

Initially, it is suggested that the primary cost-to-serve studies should be limited to large industrial service to encourage connection of industrial loads to the VPC system. In Vietnam a large number of industrial loads are being supplied with their own generation. VPC should be able to supply central station service to such customers at lower cost than they can provide their own service. A properly designed industrial rate structure should rectify the situation as long as the quality or reliability of the service provided is equal to or better than self-generated loads now enjoyed. (Section IX)

The Management Advisory Team (MAT) study recommended the establishment of a separate utilities commission with general powers to investigate and review the activities and programs of electric utilities, but with only specific and limited regulatory authority.[6] The principal area in which this commission was to be granted such authority was in the regulation of rates. The National Utilities Commission (NUC) is not the completely independent commission contemplated in the MAT report. However, it may seek assistance from the courts in regard to its decisions; and a utility may also appeal to the co ts. NUC seems to exercise, to a great extent, the basic freedoms of independent decision and action which are clearly embodied in its charter as set forth in the Decree of September 23, 1968.[7] More assurance in this respect could be gained if NUC were further removed and consideration might well be given to attaching NUC to the Prime Minister's Office. It is seriously lacking in sufficient capable professional staff and suffers from inadequate finances. (Section X)

NUC has been given operating assignments which are outside the proper role of a quasi-judicial body. The practice of using NUC as an operating agency, or giving the Chairman operational duties, dilutes the effectiveness of NUC as a regulatory body, and it is recommended, that as soon as practicable, such assignments be handled outside NUC. (Section X)

NUC provides for an independent or separate review of utility operations that could assure more efficent management and operating practices and equable service practices. The regulatory lag has been greatly reduced. There has been a vast improvement over the performance of the former interministerial Service of Control (SOC). (Section X)

NUC assures a fair rate of return on utility investments and provides for adequate capital reserves for expansion. The utilities are enabled to re-evaluate rate base and depreciation without being in direct conflict with established law. It is responsible in protecting and representing the public and national interest in utilities. It is responsive to the Utilities Committee of the

[6]Management Advisory Team, *Vietnam Electric Power Management Advisory Study,* Final Report, August 1967. Prepared for USAID. All references to MAT are from this report.

[7]GVN Decree No. 131/SL/CC/GTVT dated September 23, 1968. All references to the establishment of NUC and quotations from the charter are from this decree.

National Assembly. In this respect, it acts as an insulating agency for the utilities which precludes direct interference by government and other agencies with utilities management and operations. (Section X)

The relationship of NUC and VPC, both being under a single administrative head, is unusual. However, both are GVN agencies. The balance between VPC and NUC, at the present time, should not be detrimental to the best interests of either agency. (Section X)

NUC could have an important effect on VPC's credit rating. To the extent that NUC does its work independently and arrives openly at rates sufficient to permit VPC to reach its objectives of sufficient power at lowest practicable rates with balanced rate schedules, it can have very beneficial effects. It could be an important force in monitoring or auditing the performance of VPC, particularly in the field of accounting procedures and rate studies. (Section X)

The early planning needs of VPC, under the relatively large expansion program which will be required to meet Vietnam's power needs, can best be met by organization of a separate planning group reporting directly to the president. A system planner, financial planner, and personnel planner should be included. Later, when VPC has become a more seasoned utility, consideration could be given to having the planning for each of the functions done in the respective functional groups shown in the organization recommended in this report. (Section XI)

VPC has a large number of employes relative to its present production which amounts to 200 kWh per employe whereas, for example, the Taiwan Power Company has a ratio of over 1200 kWh per employe. It is recommended that VPC plan and manage its personnel requirements with the view of increasing the productivity of each employe by over sixfold in the 15 years to 1986. The history of successful utility companies is a constant increase in productivity per employe with growth in generated kilowatthours. The rate of growth of productivity is a very important factor in keeping rates as low as possilbe and in keeping a good credit rating. (Section XI)

The organization proposed by MAT has all the necessary elements included on a functional basis and with each principal function having its own vice president or manager. (Section XI)

The present VPC organization does not provide for the final consolidation on an organizational basis of the merger of the Saigon Power Company (SPC) and Electricity of Vietnam (EOV). The MAT proposed organization will accomplish the final consolidation and it is time that this should be done. It is recommended that the organization proposed by MAT be adopted by VPC at an early date. (Section XI)

The Board of Directors should delegate to the President and General Manager the responsibility to manage the company as well as the necessary authority to discharge this responsibility. The Board must act through the President and not independently. This is very important if the company is to operate effectively. When the President delegates responsibilities to the engineering, operating, or other departments, he must also delegate the authority to carry out these functions. The principle extends down to the lowest rung in the management ladder and should be impressed upon every level of management. Management must supervise to be sure that the delegated responsibility is fulfilled. (Section XI)

The Board of Directors determines the policies but does not assert or exercise direct control over the company's operations. It should act through the President in all matters and devote its attention to policy rather than operating details. (Section XI)

The proposed construction program will require large numbers of construction workers. By demonstration in the construction of Da Nhim hydroelectric project and the Thu Duc thermal plant, Vietnamese workers can be effectively trained to handle the work. As the US military program decreases, upwards of 20 thousand skilled Vietnamese workers will become available. By inclusion of a relatively small number of out-of-country experts and staff personnel, it should be possible to handle VPC construction manpower needs. (Section VI)

With respect to VPC maintenance and light construction needs, the availability of maintenance and construction personnel to VPC is not very large at the present time. The military services take all the able-bodied men between 17 and 38 years of age which greatly reduces the selection. Also, VPC does not pay wages which are competitive with contractor scales. Unless there is wide unemployment, VPC will continue to have difficulty unless it revises its pay scales upwards. (Section VI)

The expansion of the VPC power system will necessitate the development of an ever-increasing organization of trained personnel to operate and maintain the various power plants, transmission lines, substations, and distribution facilities.

Training programs should be inaugurated and carried on continuously with properly trained and experienced instructors for each specialized function. (Section VI)

As a means of training power plant operators and maintenance technicians, the customary practice is to assign them to the construction organization while the power plant is being constructed so that they become familiar with the equipment they will operate when the power plant is completed. This kind of on-the-job training is an excellent way to develop the knowledge and skills that the operating and maintenance personnel should have to properly operate the electrical facilities in an expanding power system.(Section VI)

Personnel training should be a constant practice to obtain efficient manning of plants. Reheat units require personnel capabilities different than nonreheat. Special emphasis should be placed on training of plant supervisors and shift foremen to familiarize them with features of the plant equipment and practices of other electric utilities having similar plant facilities. The key people who will operate the plant, either thermal or hydro, should be assigned to the plant during its construction and start-up period. (Section VI)

A computer training program should be established and additional computer system analysts having degrees should be hired as soon as possible. One part of the training should consist of sending DPC personnel to data processing departments at electric utilities outside Vietnam. (Section VIII)

Training programs should be set up in the field of rates and rate analysis. Training programs should be established in each specialized field of power system planning, design, construction, operation, and transmission and distribution. On-the-job training programs should be carried out for the various supervisors, technicians, electricians, mechanics, etc., and selected personnel should be sent to foreign countries for training so that they can become familiar with modern techniques used in the management and operation of large interconnected power systems. (Section IX)

A training program should be established for middle management, not only in their respective positions but also in corporate matters. VPC now sends select personnel to institutions to take established courses in management. In addition to this, a stay of one to two months at a utility in the US would be helpful in obtaining practical experience.(Section XI)

A careful and detailed review of existing and proposed training programs in all departments of the company and at all levels should be undertaken. Such a review in conjunction with a detailed review and study of the personnel needs of VPC for at least five years in the future will result in an estimate of the number of people in each category and the number needed in the company. A program such as this could assist in assuring only the necessary number of people required to operate and manage the company in an efficient manner. (Section XI)

SECTION II
ECONOMIC SITUATION

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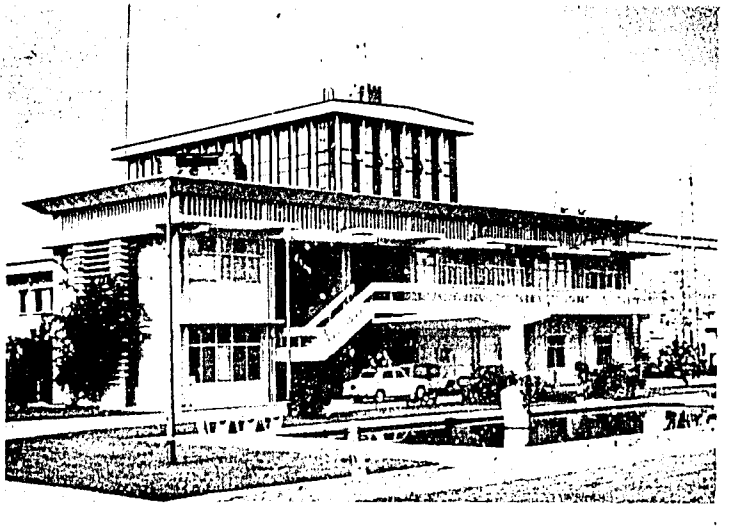

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SECTION II

ECONOMIC SITUATION

GEOGRAPHY AND CLIMATE

Vietnam is located on the southeastern part of the peninsula of Southeast Asia. It is separated from North Vietnam by a narrow demilitarized zone along the Ben Hai River at the 17th parallel of latitude.

The South China Sea is on the eastern and southern sides while Laos, Cambodia, and the Gulf of Siam form the boundary on the western side.

The country is crescent shaped with the convex side facing the South China Sea. It is approximately 1000 km in length and varies in width from 60 km at its northern border at the demilitarized zone to 200 km at the widest section. It has an area of about 170 000 km^2.

There are three principal geographical areas: the Mekong delta, the coastal region, and the central highlands or mountain region.

The delta, created by the Mekong River, is a vast, very flat, alluvial plain with elevations above 5 m occurring in only a few places. It has an area of 50 700 km^2 with an extensive network of rivers and canals and is known as the "rice bowl" of Vietnam. The larger towns in the delta, such as Can Tho and My Tho, serve as commercial centers for the surrounding agricultural areas Highways in the delta are few and in generally poor condition, and the waterways provide the dominant mode of transportation. The extreme flatness of the delta makes drainage difficult during the season when river stages are high.

The coastal region lies along the eastern coast extending from the northern boundary to the delta area. It consists of a number of narrow coastal plains separated by mountain spurs which extend occasionally to the coast. The former imperial capital of Hue and the port city of Da Nang are the major cities in the north, and Nha Trang and the port of Cam Ranh in the south.

The central highlands region includes the Annamite mountains which fall steeply to the eastern coastal plain and slope gently to the west to the basin of the Mekong River. The mountains are covered with forests, and the area is generally isolated. In the southern portion, the city of Dalat is a resort area and a center of vegetable trade.

West of the mountains, two plateau areas in the vicinity of Kontum, Pleiku, and Ban Me Thuot are mainly covered with brush mingled with a few trees. The forests originally covering these areas have been destroyed by the nomadic type of agriculture practiced by the hill tribes.

Saigon, the capital of Vietnam, is located on the Saigon River just above the confluence of the Saigon and Dong Nai rivers. Most of the country's industries are in this area and most of the foreign commerce passes through its port.

Although Vietnam is situated entirely in the tropics, its climate ranges from tropical to temperate and is dominated by the seasonal pattern of the monsoons. The southwesterly monsoon comes from the Gulf of Siam and brings heavy rain to the delta and the central highlands during the months from June to November. The central cordillera forms a natural barrier to the passage of the monsoon rains to the central coast area and this area is dry during the same period. The northwesterly monsoon comes from the Gulf of Tonkin and brings rain to the east coast from December to March. Thus, Vietnam has two "rainy" seasons depending on the particular area. Table II–1 shows the average monthly rainfall in relation to the regions in Vietnam and Table II–2, meteorological data.

ECONOMIC OUTLOOK

Present Situation

The economy of Vietnam, immediately after the 1954 split, was based very largely upon agriculture. North Vietnam retained the only real manufacturing industry, based on mineral deposits near Hanoi, and Vietnam was left, as far as industry was concerned, with only rice mills, sugar mills, and other plants engaged in processing agricultural products. The population of Vietnam in 1954 was about 85 percent rural, and the only major city, Saigon, owed its existence chiefly to its being one of the world's leading rice milling and shipping ports. In peacetime, before 1954, Saigon had sent abroad as much as a million tons of high quality rice a year, all grown in the Mekong delta and mostly milled in Saigon. Through Saigon also passed the output of the rubber and tea plantations which are spread in an arc to the north and east of the city.

Since 1954, this relatively simple economic pattern has changed sharply, and it is greatly distorted by the effects of war which have caused a distorted spending pattern, inflationary pressures, a

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TABLE II-1

ANNUAL PRECIPITATION IN VIETNAM BY REGION AND BY MONTH

(DATA FROM VIETNAM STATISTICAL YEARBOOK 1969 NATIONAL INSTITUTE OF STATISTICS, GVN)

Millimeters

Region*	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Delta	16.4	11.9	55.0	65.1	333.7	292.5	319.7	359.5	352.5	426.0	183.5	85.2	2 500.7
Highlands	9.1	19.7	65.0	91.4	303.2	213.7	375.6	286.9	314.1	148.1	141.5	75.7	1 843.3
Southern Coastal	30.7	17.4	16.7	24.1	172.5	95.4	115.9	132.4	128.1	257.4	216.6	102.7	1 309.6
Northern Coastal	129.6	89.2	61.7	24.7	162.4	39.4	54.6	135.6	280.4	576.5	564.2	339.6	2 359.9

*These figures are averages from the figures of the provinces in each region:

Delta: Phu Quoc, Rach Gia, Khanh Hung, and An Xuyen provinces.
Highlands: Pleiku, Ban Me Thuot, Dalat, and Bao Loc provinces.
Southern Coastal: Tuy Hoa, Nhe Trang, Phan Thiet, and Vung Tau provinces.
Northern Coastal: Quang Tri, Hue, Da Nang, and Qui Nhon provinces.

TABLE II-2

METEOROLOGICAL DATA FOR VIETNAM

(FROM DATA COMPILED BY VPC)

TEMPERATURE-DEGREE CELSIUS

Observed Period	1931–44 1947–68 Da Nang	1930–44* 1947–68 Cam Ranh	1937–44** 1954–68 (Highlands) Ban Me Thuot	1929–44 1947–68 Saigon	1937–40 1962–68 Can Tho
Temperature					
Average daily per year	25°6	26°5	23°4	27°0	26°9
Average daily max per year	29°8	30°7	28°9	32°1	31°5
Average daily min per year	22°6	23°0	19°8	23°3	23°3
Absolute maximum	40°9 (1957)	39°5 (6–1912)	39°4 (1937)	40° (1912)	40° (1967)
Absolute minimum	11°0 (1932)	(8–1950)	7°4 (1955)	13°8 (1937)	14°8 (1965)
		14°6 (2–1918) (1–1940)			
Thunderstorms (Observed period)	1950–68	1950–68	1955–68	1950–68	1950–68***
Average No. of days per year					
–Less than 3 km from station	13.9	10.8	17.7	40.6	21.3
–More than 3 km from station	30.0	29.2	36.4	48.5	42.6
Max wind velocities in knots	56	47	32	44	60.0
Max wind direction	E	WNW	ENE	W	ESE

*Observed period for average only. For Max and Min temperature: 1907–44, 1947–68
**Observed period for average only. For Max and Min temperature: 1928–44, 1954–68
***At Khanh Hung station, 40 km southeast of Cam Tho

flood of refugees who fled from North Vietnam and from the insecure rural areas to the more protected cities, and a disruption of agricultural production.

Despite all of its troubles, Vietnam has made some headway. The National Bank of Vietnam reports that ". . . the national economic situation in 1970, in general had made satisfactory progress ..."; that "A five-year plan for the development of the rural economy will be implemented from the beginning of 1971 . . ."; and that "The industrialization program will be strongly promoted in 1971 . . ."[1]

GVN has established the Bien Hoa Industrial Park about 32 km northeast from Saigon and as of March, 1971, 33 plants were in operation, 14 completed with machinery and equipment being installed, 17 under construction, and four sites being graded. They range from a government-owned sugar and alcohol plant employing 1000 people and a privately owned steel rolling mill, Vietnam's first, to brick and ice-making facilities with half a dozen employes. Employment in the park numbered over 3000 in 1970 and is increasing.

A wide variety of products is manufactured among which are detergents, aluminum wares, machinery and machine tools, knit wools and textiles, small engines, glass bottles, plastic goods, paper and cardboard products, lead batteries, chemicals, and bicycle tires. A small automobile assembly plant is planned, and there are assembly plants for watches, motorcycles, radio and TV sets, and electric fans.

Another industrial park has been created just north of Can Tho in the delta area and a third park is under consideration in the Da Nang area.

The GVN program of establishing industrial parks demonstrates the stated determination of GVN to lay a basis now for fuller utilization of the country's resources and manpower despite the many difficulties now existing.

Future Outlook

JDG made a study in depth beginning in February, 1967 of the postwar development of Vietnam, and in March, 1969 submitted a report of the future of the economy of Vietnam.

Since the national power survey for Vietnam looking ahead for a period of 15 years is, in essence, a projection for the future economy of Vietnam, the discussion and conclusions of the JDG report are important to the purposes of this report.

The JDG report concludes that Vietnam can achieve economic independence in the context of its relationship with Southeast Asia and the rest of the world and that the Vietnamese economy will continue to grow and its people to prosper on the strength of their own skills and resources without continuing dependence or concessionary aid from overseas. And, it further concludes that this objective can be achieved within a period of ten years after the war comes to an end.

JDG assumed a "minimum" and "maximum" path for the future economy cautioning that these were not exact terms. The minimum path suggests a GNP growth of about five percent per annum for the decade following the war. The maximum path would have a GNP growth of about seven percent per annum.

Under the minimum growth, agriculture would continue to be the largest component of the GNP. The net growth of the economy, after providing for increases in population, would be relatively small and the per capita income would grow by a total of only about 20 percent over the ten-year period.

Under the maximum growth of about seven percent GNP, the per capita income would grow by about 36 percent. The JDG report states that "...if appropriate policies are applied and there is a determined effort to increase investment and exports, then the maximum figure might well be exceeded."

TRANSPORTATION AND UTILITIES

Chiefly as a result of military needs, Vietnam now has about 4000 km of asphalt and macadam paved roads forming the national highway system which provides an adequate network of serviceable communications among major centers. The total of all types of roads is stated to be 21 000 km, most of which needs reconstruction and upgrading.

The government-owned Vietnam National Railway System (VNRS) comprising about 1400 km of main and branch lines has been extensively damaged, particularly the bridges, as a result of the war in recent years. The railways extend mostly northward along the coast from Saigon to Da Nang and Hue. Branch lines to Dalat, Phan Rang, and other centers also exist. The government- initiated railroad rehabilitation program has been progressing rapidly, and by the end of 1970, 57 percent of the 1240 km of main lines was made operational.

The inland waterways of Vietnam have long

[1] National Bank of Vietnam, *Annual Report Fiscal Year 1970.* GVN, 1971. All quotations attributed to the National Bank of Vietnam are from this report.

been in use. In some of the delta areas, water transport remains the only means of travel. The country's approximately 4800 km of inland waterways are used by vessels of varying sizes up to ten tons. During 1970, the government initiated a program for the improvement of the waterway system and established the Directorate of Navigation as an autonomous agency to handle such improvements.

Deep-water port facilities have been improved to handle the large volume of military and commercial imports. A new port has been constructed in Saigon and cargo handling facilities greatly expanded. The Da Nang port has been improved by the US armed forces and, with the reduction in the level of military activities, the port will have sufficient facilities for the future handling of commercial traffic. The US armed forces have also constructed another important port at Cam Ranh Bay which will become available for commercial use.

Air communication in Vietnam, now mainly for military purposes, has become increasingly important. Over 100 operation airports have been constructed. The largest of these airports, which are capable of handling large jet aircraft, are located at Saigon, Da Nang, Can Tho, and Cam Ranh. In view of the existence of this well-developed system of airports, the country is well supplied with adequate landing facilities.

The internal and international telecommunication services are under the Directorate of Post, Telephone, and Telecommunications (PTT). Vietnam's telecommunications network is a complex of diverse systems maintained by the PTT, GVN armed forces, the National Police, and the civil aviation authorities. The US armed forces, however, maintain a very sophisticated network. The PTT has started planning for the establishment of a single integrated telecommunications system. A national broadcasting service and a national television service have been established and are in operation.

The demand for electric power is very high and a severe shortage exists. The rates for power, particularly for industry, are very high and constitute a serious problem in the encouragement of industrial expansion. In many varieties of industry, studies indicate that self-contained power plants would be more economical than service from existing utilities.

Piped public water supply exists only in the Saigon, Da Nang, and Hue areas and to a limited degree in other urban communities. Programs for extending such systems in other communities are under way. The balance of the country relies on wells, canals, and rivers which represent readily available sources of water.

POPULATION

Population Growth

Population figures for Vietnam are not very reliable. The last census was made in 1960 and subsequent figures have been approximations. On the basis of reports from provinces and municipalities, the population of Vietnam is stated at 17 333 000 in 1970.[2]

Various estimates have been made of the population growth. During the 17-year period ending in 1960, the population grew by 4.4 million people at a compound annual growth rate of slightly over two percent. Since 1960, a compound rate of 2.5 percent has generally been assumed to hold with some evidence that in recent years the rate has been somewhat higher. In 1968, the US State Department Vietnam Information Notes stated that "The population of South Vietnam is approximately 17 million and is increasing at the rate of 2.8 percent annually."

JDG, in its report, adopted a rate of growth of 2.6 percent. Table II–3 shows population projections based on 2.0, 2.6, and 2.8 percent rates of growth compounded annually from 1970.

In a report prepared for USAID, the population in 1970 is estimated at 18 770 000 based on figures in Vietnam Statistical Yearbook 1969. The 1970 yearbook, which subsequently became available, shows an official figure of 17 333 000 population for 1970 which has been adopted for use in this report. In projecting the population to the year 2000 on two different bases, the Metcalf and Eddy report gives a high average annual rate of 2.71 percent and a low average annual rate of 2.48 percent.[3] An average of these two figures results in an annual rate of growth of 2.54 percent.

In attempting to adopt a rate of growth, it should be noted that the rate of population increase was 1.8 percent in 1956, 2.6 percent in 1962, and 3 percent in 1967. From 1967 to 1970, the increase averaged 2.2 percent. There seems to be no good reason at this time for changing the

[2]National Institute of Statistics, *Vietnam Statistical Yearbook 1970.* GVN 1971. All references to and quotations from a 1970 yearbook are from this book.

[3]James E. Bogle, AIP, *Year 2000 Population Projections for Republic of Vietnam and Saigon Metropolitan Area.* Prepared for Metcalf and Eddy, Inc. Engineers under Contract No. AID/vn-86. March 1971.

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TABLE II–3

Population Projections for Vietnam 1971 through 1986 (in thousands)

Year	2.0 Percent Growth Rate	2.6 Percent Growth Rate	2.8 Percent Growth Rate
1970	17 333	17 333	17 333
1971	17 680	17 784	17 818
1972	18 034	18 246	18 317
1973	18 395	18 720	18 830
1974	18 763	19 207	19 357
1975	19 138	19 706	19 899
1976	19 521	20 219	20 456
1977	19 911	20 745	21 029
1978	20 309	21 284	21 618
1979	20 715	21 837	22 223
1980	21 129	22 405	22 845
1981	21 552	22 988	23 485
1982	21 983	23 586	24 143
1983	22 423	24 199	24 819
1984	22 871	24 828	25 514
1985	23 328	25 874	26 228
1986	23 795	26 547	26 952

rate of growth adopted by JDG of a 2.6 percent rate of annual increase. It is recognized, however, that before the end of 15 years there could and probably will be events which may have a significant effect on population growth. Subsequent forward-looking population estimates should be alert to changes in existing patterns.

Distribution of Population

Population and economic activity in Vietnam is not evenly distributed throughout the country. The Annamite mountain chain that generally runs parallel to the coast makes the northern portion of Vietnam less hospitable for agriculture than the flat, rich delta area to the southwest. Population concentration is heaviest in the delta where much of the alluvial soil is enriched annually by the flooding of the Mekong River system.

About two-thirds (11.2 million) of the people live in southern Vietnam which comprises the Mekong delta, the Saigon metropolitan area, and the area up to and including the provinces of Tay Ninh, Binh Duong, Bien Hoa, Long Khanh, and Binh Tuy.

The great majority of the population is of Vietnamese descent. The more numerous minorities each number less than one million and include the Montagnards (hill people of Malay stock) who live in a variety of tribes in the central highlands, the Khmers (Cambodians) who live principally in the delta and along the coast north to Da Nang, and those of Chinese origin who live in southern Vietnam, mostly in the Cholon area near Saigon.

The central Vietnam lowlands, as delineated in the 1970 yearbook, include the ten coastal provinces north from and including Binh Thuan Province to the border with North Vietnam. In this region, there were more than 5.2 million people in 1970. The remaining seven provinces comprising the central Vietnam highlands contain more than 907 000 people.

AGRICULTURE

General

Vietnam has been an agricultural nation for many years, and agriculture will probably continue to be the keystone of the local economy for some time. In 1967, it was estimated that over 70 percent of the population was involved directly in the production of crops, animal products, and fishery products. Agriculture was the principal source of exchange earned through exports, with rice and rubber being the major export commodities.

Five-Year Rural Economic Development Plan (RED Plan)

The Ministry of Land Reform and Agriculture and Fishery Development (MLRAFD) RED Plan report compares the agricultural development potential of Vietnam and the Republic of China (ROC).[4] On a comparative basis, Vietnam has a very promising potential for future economic development.

Forestry

About one-third of the area of Vietnam consists of forest land. These forests contain hardwoods of very high value. The so-called luxury woods, such as rosewood, ebony, sandalwood, fine mahogany, camphor wood, and others are all in great demand. Numerous other types of wood with great resistance to insects and borers and possessing high density, strength, and toughness are suitable for high-quality durable construction. In addition, many species of desirable but lower quality woods are useful for construction lumber and less exacting uses.

The woods in these forests compare very

[4]Ministry of Land Reform & Agriculture & Fishery Development, *Five-Year Rural Economic Development Plan (Agriculture, Fisheries, Forestry & Animal Husbandry) 1971–1975.* GVN, 1971.

favorably with those found in such countries as Malaysia and the Philippines.

At the present time, Vietnam is a net importer of lumber and lumber products. It is projected by USAID that this deficit could be reversed and by 1975, exports could exceed imports by US$25 million to US$35 million and approximately US$100 to US$140 million in good grade lumber could be made available for the domestic market.

The potential export possibilities, after ten or fifteen years, could grow to in excess of US$200 million annually based on constant 1971 dollars and assuming planned management of the forests, sustained or perpetual yields, restoration of cutover forest lands, research, and government policies which will be inviting for participation of foreign private capital investments.

MANUFACTURING

Manufacturing activities expanded appreciably between 1954 and 1970 due to increased demand generated by the large armed forces of Vietnam and its allies and to increased urbanization and availability of foreign exchange from external sources. Despite this increase, however, the relative contribution of manufacturing to the gross domestic product declined from 10.6 percent in 1960 to 4.2 percent in 1969 as a result of the enlarged relative contribution of agriculture.

The National Bank of Vietnam reports that "After a strong recovery in 1969 the rate of industrial growth declined in 1970. The general index of industrial production increased only by 14 percent (from 214 to 245) compared with 25 percent in 1969." Paper and paper products, lime, cement, beverages, and textiles, for example, increased, but transport equipment assembly, machinery, electrical appliances, and aluminum products production fell markedly. Construction activities expanded at a slower pace, due to the impact of the withdrawal of allied forces, from a growth of 45 percent in 1969 down to 13 percent in 1970.

The Bien Hoa Industrial Park (500 hectares) has been completed and the Can Tho Industrial Park (200 hectares) is under development by the National Society for the Development of Industrial Zones, a government-owned corporation.

In order to provide incentives for domestic and foreign investment, GVN has submitted a new investment act to the National Assembly for ratification. The special law relating to petroleum exploration and exploitation has been ratified by the National Assembly.

No coordinated efforts have been made to formulate a plan for industrial development although a list of priority projects soliciting foreign and domestic investment is maintained and changed from time to time. The establishment of a fertilizer plant, a refinery, two cement plants, and grain storage facilities is presently being given priority.

Many industrial development possibilities have been suggested, such as chemicals, petroleum processing, paper and paper pulp, textiles, automotive tires, cement, sugar, glass, steel and cast iron, aluminum products, hardware and tools, bicycles, home appliances, sewing machines, porcelain ware, leather products, wood products, and food products. Some of these industrial development possibilities have been studied and reported upon under USAID programs.

Cement Industry

At the present time, the government-owned Ha Tien Cement Company is the only cement manufacturer in Vietnam. It began operations in 1961 with a production of 75 000 metric tons. The operating facilities of the company are in two widely separated locations. The quarry and a 240 000 metric ton per year clinker-producing plant are located near the town of Ha Tien in Kien Giang Province on the Gulf of Siam near the Cambodian border. From there, a fleet of more than sixty 300 metric ton canal barges carry the clinker northeast to a clinker-grinding plant located at Thu Duc, 10 km north of Saigon. The Thu Duc grinding plant has a capacity of 300 000 metric tons per year. Neither facility has reached sustained capacity production due to wartime troubles.

In May 1970, a feasibility report was made to USAID on the cement manufacturing industry in Vietnam covering a period from 1970 to 1980.[5] It reported that the projected cement market for Vietnam will grow from 800 000 metric tons in 1970 to 1 515 000 metric tons in 1980.

Based upon the results of the market study and economic feasibility analysis, it was recommended that two new cement manufacturing facilities be constructed, one facility to be located at Can Tho in the Phong Dinh Province in the delta area and the second to be located at Van Xa in Thua Thien Province approximately 10 km northwest of Hue. Both facilities would have a rated capacity of 250 000 metric tons per year, which is an economically efficient plant size.

[5]Kaiser Engineers and Constructors, Inc., *Feasibility Report, Cement Manufacturing Industry.* Prepared for USAID, May 1970.

Electrical Industry

Distribution Transformers–

Distribution transformers represent a significant portion of overhead distribution investment. A large number of these transformers is required on any rapidly growing electric utility system because each transformer, regardless of its size, is capable of serving only a few customers. The total additional capacity required annually in distribution transformers is closely related to the system load and rate of growth.

A study made in 1965 concluded that establishment of a distribution transformer factory in Vietnam at that time was not recommended.[6] It was stated, however, that when system demand reaches 200 MW with an annual growth rate of ten percent, the establishment of a factory should be undertaken.

The consultant report cited overall costs of production in the proposed factory to be approximately 40 percent higher than for completely assembled imported transformers. Further analysis, however, showed a substantial annual savings in foreign currency can be realized if the plant is established when the above minimum conditions are attained. It was estimated that these savings within three years would be sufficient to offset the initial foreign currency portion required to establish the plant.

VPC system peak is now near the 200 MW level and much faster annual growth rates are anticipated than the ten percent criterion set by the Nippon Koei study. Based on the original study, it was estimated that the annual distribution transformer requirement in Vietnam would be approximately 45 MVA. Beginning in 1972 and using a more conservative ratio (1.8 MVA/MW system growth) the initial annual requirement for these units is estimated on the basis of presently projected load growth, to be approximately 150 MVA. Within the ensuing 15-year period, it is projected that the annual requirement will exceed 400 MVA.

Based on extrapolation of the Nippon Koei formula and escalation to year 1971, the approximate value of 150 MVA in a mix of various sizes of finished transformers at the plant is US$2.9 million. On a similar basis, production of transformers with a total value of approximately US$83 million will be required in 15 years to satisfy distribution requirements. Approximately 48 percent of these costs are in foreign exchange; the remaining 52 percent are local funds.

The plant size anticipated in the 1965 study proposed employment of approximately 70 people. In order to cope with the production, which appears necessary to satisfy all requirements in Vietnam, a larger plant and additional personnel are indicated.

Insulators–

In June, 1965, a report was submitted which showed that a plant having a capacity of 148 tons a month would be feasible.[7] Of this amount, 15 tons would be insulators for the distribution system; the balance of the production would be in wall tiles, mosaic tiles, and porcelain wiring materials.

It is estimated 235 tons of insulators will be required to meet the proposed construction schedule in 1972. In the following four years, the annual requirements will be above this amount for the proposed construction. In the years 1977 through 1986, the requirements should be equal to or greater than the 235 tons per year.

The insulator requirements for the proposed construction program will be approximately 20 tons a month which is greater than the amount shown in the June 1965 report. If the wall tile and ceramic tile portion of the factory production can be realized, the insulator requirements for the distribution system can be manufactured in Vietnam with a saving in foreign fund requirements.

Watthour Meters–

Utilities require large quantities of watthour meters because essentially each new customer requires an individual meter. In Vietnam, there also exists the situation of many subcustomers and illegal taps. VPC will be required to purchase many meters to correct this situation.

A feasibility study conducted in 1965 indicated that Vietnam requirements at that time were insufficient to support a factory for watthour meter manufacture.[8] For economical operation, it was concluded that approximately 3000 meters per month (36 000 annually) should be produced. The demand for such a quantity was not expected to be reached until the system load approached 300 MW with an annual growth rate of ten percent.

The consultant's report was not optimistic as regards any advantage in savings of either foreign

[6]Nippon Koei Co., Ltd., *Feasibility Report on the Distribution Transformer Factory.* Prepared for GVN, June 1965.

[7]Nippon Koei Co., Ltd., *Feasibility Report on the Ceramic Factory.* Prepared for GVN, June 1965.

[8]Nippon Koei Co., Ltd., *Feasibility Report on the Watthour Meter Factory.* Prepared for GVN, June 1965.

or local exchange resulting from local manufacture. It did, however, recognize some value in training and development of techniques in local personnel. Employment of approximately 50–70 people was anticipated in the early stages of operation.

Assessment of probable requirements for watthour meters by VPC indicates that beginning in 1972 , annual needs will exceed 130 000 units and will increase to more than 230 000 in later years. The total quantity expected to be required for the 15-year program is approximately 2.5 million. Assuming these were all single phase meters and based on VPC's present cost of approximately US$20 per unit, the value of year 1972 requirements would be in excess of US$2.5 million and that of the 15-year program requirement would be approximately US$50 million.

In view of the long-range possibilities in local markets and elsewhere, it would appear that a reassessment of feasibility of local manufacture or assembly of various types of watthour and demand meters is appropriate.

Miscellaneous–

Opportunities for various other new or expanded industrial and small industrial operations exist in Vietnam as in other countries throughout the world. For example, the assembly for export of electronic components into products, such as transistorized radios, television sets, and various electrical instruments, could be carried out in Vietnam as it is being done in Korea. Similarly, the many household electrical appliances might be assembled in Vietnam in collaboration with foreign manufacturers.

Automobile, motorbike, and bicycle assembly operations might be expanded in country to satisfy a demand which will certainly grow with the economy and outward expansion of residential areas.

When additional experience has been gained and as sufficient capital becomes available through an expanding economy, a greater in-country manufacture of parts and components may become attractive. Imports then would tend toward greater quantities of basic raw materials. This evolution in industrial development will provide many challenges and opportunities for a growing number of capable Vietnamese engineers and technically trained people.

Industrial Power Sales

The lack of definitive plans for industry makes it difficult to provide other than a very rough estimate of future industrial power sales.

VPC, in its five-year development program, estimates industrial sales in 1975 at from 50 to 60 percent of total sales. In the Saigon area, it assumes industrial sales could be around 70 percent and in most of the delta area, which is highly agricultural, possibly as low as 20 to 30 percent with the exception of such centers as Can Tho which could approximate the Saigon area percentages of industrial sales. The Da Nang, Nha Trang, Dalat, and Qui Nhon areas might have a rate of industrial sales of 50 percent.

For comparison, an examination of the Taiwan Power Company report shows 77.2 percent of its total energy sales was to industrial consumers who supplied 60.4 percent of the total electric revenues.[9] A Korea Electric Company report indicates industrial sales at about 78 percent of total sales.[10] An Israel Electric Corporation, Ltd. report indicates industrial power sales as 61.1 percent of the total energy sales which yielded 38.5 percent of the revenues.[11]

It could be assumed that industrial sales in Vietnam might increase from 50 to 60 percent in 1975, to 60 to 70 percent in 1986, or an average of from 55 to 65 percent, respectively. If so, the industrial energy load would be estimated at about 1620 GWh in 1975 and 8200 GWh in 1986. At 60 percent load factor, the peak industrial demand would be about 300 MW in 1975 and 1560 MW in 1987. The years in between could be assumed to grow progressively and adjusted as necessary at each annual review.

[9] Taiwan Power Company, *Taipower 70.*

[10] Korea Electric Company, *Annual Report for 1970.*

[11] Israel Electric Corporation, Ltd. *Forty-Seventh Annual Report, 1969–70.*

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ENERGY RESOURCES

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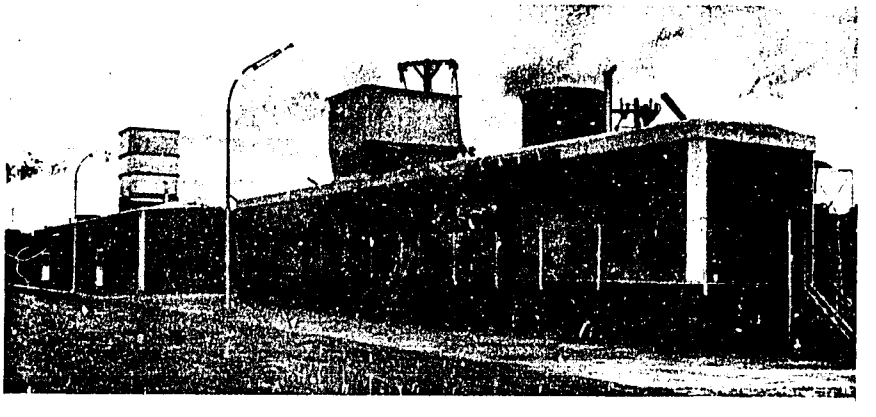

GAS TURBINE PLANT

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SECTION III

ENERGY RESOURCES

FOSSIL FUELS

Coal

There is only one known coal deposit in Vietnam. It is located at Nong Son about 40 km southwest of Da Nang. It has been estimated that, assuming 60 percent recovery, the known minable reserves amount to 7.2 million metric tons of which 2.7 million metric tons could be recovered by strip mining and 4.5 million metric tons by underground mining. There are unproven possibilities of other deposits in adjacent areas

The quality of the Nong Son coal is inferior and does not compare favorably with the anthracite coal found in North Vietnam which was formerly used in Vietnam. The Nong Son coal is an anthracite with the combustibles containing 90 to 95 percent carbon and 5 to 7 percent combustible gas including 1.8 to 2 percent hydrogen. The ash content ranges from 20 to 32 percent. The high sulfur content of the coal makes it unsuitable for iron or steel manufacture and the phosphorous content precludes its use for the manufacture of calcium carbide.

This coal was used, to some extent, for thermal generation of electricity before mining operations had to be discontinued because of lack of adequate security. As mined, large quantities of foreign material adhere to the coal which has to be removed before the coal is suitable for industrial use.

It had been planned to develop an industrial complex at An Hoa to utilize Nong Son coal for the production of chemical fertilizer and thermal power. Large amounts of money were spent on the fertilizer plant and equipment for a 25 000-kW thermal generating plant, including materials for a transmission line to Da Nang and Hue.

It also was the plan to utilize Nong Son coal in other industries, such as the manufacture of cement, brick, clay, tile, ceramics, and glass at the An Hoa Industrial Complex. These plans have not materialized and the fertilizer plant, which was designed a decade ago, is now considered to be obsolete, and the equipment which was purchased for the thermal plant is to be converted by VPC to oil fuel and installed at Da Nang for utility service.

Oil and Gas

No oil or gas has been discovered in Vietnam thus far. Geological investigations and some preliminary test drilling are reported to indicate that oil may be discovered in offshore areas in the vicinity of Cam Ranh and Ca Mau. All fuel oil used in Vietnam is now imported. Several of the large oil companies operate oil storage facilities in the Saigon area, and additional facilities are planned at Cam Ranh.

The present price of fuel oil (1971), less any domestic taxes, for the Thu Duc thermal generating station is reported to be US$14.40 per metric ton which is equivalent to US$0.36 per million Btu.

This figure was used to determine the cost-benefit ratios of hydroelectric plants. By the end of 1971, just as the report was finally being edited, oil prices were increased The effect on the hydroelectric plants is to increase their attractiveness since higher fuel costs increase the cost of production from thermal plants.

Fuel, Wood and Charcoal

These fuels are used to a considerable extent for domestic heating and cooking, particularly in the rural areas where electricity is not available. Wood is readily available in these areas and is less expensive than kerosene. Use of these fuels, no doubt, will continue in the future.

Other

The wind, tide, and solar energy are available in abundant quantities. However, the technical problems involved in their use preclude them from consideration.

Although there are hot springs reported in Vietnam, no explorations have been made to gauge the feasibility of geothermal generating plants. It is not probable that they would be an important consideration in future provision of generating capacity but, if any such installations should become feasible, they can be readily incorporated into the future generation planning.

HYDROELECTRIC POWER

General

Vietnam is richly endowed with water resources. Preliminary investigations made thus

far of some of the larger streams indicate that there may be a total of over four million kilowatts of potential hydroelectric power. The actual amount of feasible hydroelectric power must await the acquisition of more complete hydrological data. Some of the projects are multipurpose involving hydroelectric power, irrigation, and flood control.

Hydrological data are essential for planning, design, and operation of hydroelectric power projects. This information is needed to determine the proper capacity to be installed in the power station, the quantity of energy that can be produced, the capacity of spillways required for discharging flood flows, etc.

Unfortunately, there is a dearth of hydrological information for most of the potential hydroelectric power sites in Vietnam. The war and lack of security have prevented establishing stream gaging stations in many areas and, in some instances, established gaging stations have been discontinued because of this situation. The stream flow records which are available cover a relatively short period of time and are more or less fragmentary.

Meteorological records are more extensive and cover a much longer period of time than the stream flow data, and this information is useful in estimating stream flows where records are not available.

VPC maintains a number of gaging stations on streams having good possibilities for hydroelectric power development, and a few stations on tributaries of the Mekong River in Vietnam are maintained by the Mekong Committee. It is very important that stream flow gaging stations and weather recording stations be established and maintained on all streams and watersheds which have potential hydroelectric power possibilities.

In the absence of long-time stream flow records, a synthesized stream flow record may be developed by using a computer program to analyze the available short-time stream flow data and meteorological records for the basin in which the stream is located. By correlating the stream flow thus obtained with actual stream flows of nearby or similar streams and making suitable adjustments, an approximation of the stream flow can be developed. Arrangements have been made recently with the Mekong Committee Secretariat to undertake a computer program to develop synthesized stream flow records for each of the major streams in Vietnam. The data thus obtained will be of great value for studying and planning future hydroelectric power, irrigation, and flood control projects.

Existing Hydroelectric Power Projects in Vietnam

There are, at present, four hydroelectric generating stations in Vietnam. These are listed in the following tabulation:

Project	Capacity kW	Year Completed
Drayling	480	1933*
La Nao	280	1939
Ankroet	3 100	1945**
Da Nhim	160 000	1964***

* *Power supplied to Ban Me Thuot.*
** *Power supplied to city of Dalat.*
*** *Water is supplied from this project for irrigation of 12 800 hectares in the Phan Rang area.*

It is planned to construct a new generating station at Drayling Falls which is to have an initial capacity of 8 000 kW and an ultimate capacity of 12 000 kW.

The existing Da Nhim hydroelectric project is located on the Da Nhim River about 30 km southeast of Dalat and about 250 km northeast of Saigon. It has a total generating capacity of 160 MW consisting of four units which operate under a gross head of 800 m. The project was completed in 1964 and supplied power to Saigon until the 230-kV transmission line was sabotaged in 1965. The generating station continued to operate, supplying a small amount of power to Dalat and local customers, until November 29, 1967, when both penstocks were ruptured. Since then, the power plant has been out of service. Repairs to one of the penstocks are now being made and are expected to be completed by November 1971. Repair of the second penstock is planned to be completed in 1972.

It is also planned to repair the 230-kV transmission line to Saigon in 1973 and to construct a 66-kV transmission line, 40 km in length, from the generating station to Dalat, Song Pha, Phan Rang, and Cam Ranh.

The cost of the repairs to the penstocks has been estimated by VPC at US$2.5 million. This expense is being borne by the Japanese.

Potential Hydroelectric Power

The following tabulation lists some of the potential hydroelectric power in the major river

basins in Vietnam. Further investigations may disclose additional potential power.

River Basin	Potential Power MW
Song Bo	45
Vu Gia	275
Upper Sekong	75
Upper Srepok	280
Upper Se San	800
Song Ba	240
Dong Nai	2 300
	4 015

Because of insecurity in the remote areas where most of the potential hydro projects are located, it has been impossible to carry out the field investigations which are essential to determine their technical and economic feasibility.

Mekong River Potential Hydro Power

The potential hydroelectric power possibilities on the lower Mekong River are tremendous. Figure III–1 shows the drainage basin of the lower Mekong River, the locations of the potential water resource projects, and the portion of Vietnam which is located geographically within the Mekong Basin. Preliminary studies indicate that seven sites, from Laung Prabang in Laos to Sambor in Cambodia, have a total potential of 23 325 MW. Eventually this great resource will be developed and low-cost hydro power will then become available for utilization in Laos, Thailand, Cambodia, and Vietnam.

The Sambor project is of particular interest to Vietnam because the transmission distance from the project to Saigon is about 230 km, which is a little less than the distance from the Da Nhim hydro project to Saigon. This project, when integrated with the large upstream storage projects at Pa Mong and Thakhek, would have a capacity of 3 250 MW and would produce, in an average year, about 19 903 MWh. The cost of energy at the generating station is estimated at 3.37 US mills per kilowatthour.[1] It appears that, if and when the Sambor project is constructed, it could provide a large amount of very low-cost power and energy for utilization in Vietnam.

While the potential hydro power on the lower Mekong River probably will not be developed for several decades, this future source of power should be kept in mind in long-range planning for Vietnam. However, this need not affect the power development program for the next 15 years.

Following is a list of some of the major potential hydroelectric power projects in Vietnam showing the present status of their investigations and planning (Table III–1).

The locations of some of the potential hydroelectric projects are shown on Figure III–2.

Estimated Cost of Construction of Projects

The estimated capital cost of each potential hydro project is shown in Table III–2. Most of the basic estimates of cost were made by Nippon Koei Co., Ltd. Others were made by the former EOV and by VPC. For the purposesof this report, the basic estimates were escalated to 1971 at the rate of four percent per year compounded annually from the year in which the estimate was made.

Estimated Annual Cost of Operation and Maintenance of Projects

The annual cost of operation and maintenance of hydroelectric generating stations varies with the size of the plant and with the extent that they are equipped with electronic and automatic control devices. Considering that the cost of labor in Vietnam is relatively low, it is assumed that, in general, the plants will be designed for manual operation in order to minimize the investment in sophisticated electronic and automatic control equipment. For the purposes of this report, the curve shown on Figure III–3 has been used to estimate the annual cost of operation and maintenance of the hydro generating stations which have been included in the power development program.

Evaluation of Potential Projects

For the purpose of evaluating potential hydroelectric projects, it is assumed that the cost of hydroelectric power and energy, delivered at load centers, would not exceed the cost of an equivalent amount of power and energy produced by the lowest cost alternate source of power delivered at the same load centers. In the case of the integrated system, the alternate source of power would be large, highly efficient oil-fired

[1] Mekong Committee Secretariate, draft of report on *Amplified Basin Plan – A Proposed Framework for the Development of Water and Related Resources of the Lower Mekong Basin*, Two Volumes. Prepared in collaboration with ECAFE. 1970

TABLE III-1

Project	Ultimate Capacity MW	Present Status
Da Nhim Extension	106	Investigations complete. Final design complete. Construction could start as soon as authorized and arrangements made for financing. Hydrological data good but limited to short period of time.
Drayling Falls	12	
Yali Falls (small)	6	
	124	
Da Nhim 2	35	Preliminary investigations have been made indicating projects would be feasible economically. Additional field investigations necessary for final designs. Hydrological data, covering short period of time, good.
Da Nhim 3	31	
Da Quayon 1, Stage 1	270	
Da Quayon 1, Stage 2	270	
Da Quayon 2	100	
Yali Falls	200	
Song Ba (Binh Dinh)	150	
	1056	
Tri An	240	Preliminary desk studies have been made from maps only.
La Nga 2	140	
La Nga 3	40	No field investigation.
Song Bo	20	
Thu Bon	80	Meager hydrological data.
La Nga (remainder) and Da Rgna	476	
Upper Se San	500	
	1496	
Total	2676	

TABLE III-1

TABLE III-2

Project	Initial Inst Capacity MW	Basic Est of Cost US$M	Year Basic Est Made	1971 Escalated Est Cost US$M
Da Nhim Extension	106	41.0	1967	48.0
Da Nhim 2	35	15.0	1965	19.0
Da Nhim 3	31	12.5	1965	15.9
Tri An, Stage 1	120	39.4	1965	50.0
Da Quayon 1, Stage 1	270	81.1	1965	103.0
Da Quayon 1, Stage 2*	270	34.4	1965	43.7
Da Quayon 2	100	35.1	1965	44.6
Drayling	12	5.1	1969	5.5
La Nga 2 and 3, Stage 1	90	37.0	1966	45.2
Thu Bon	80	31.4	1965	41.2
Song Ba**	150	44.3	1969	48.0
Yali Falls	200	45.0	1966	55.0
Upper Se San	500	200.0	1966	244.0
La Nga and Da Rgna, Stage 2***	476	128.0	1966	190.0
Song Bo	20	6.5	1969	7.0

**Generating stations at Da Kanan 1 and 2, Upper Da Dung, and Cam Ly dams omitted.*
***Includes also 53 percent of cost of An Khe dam allocated to irrigation.*
****Estimated at $400 per kilowatt.*

TABLE III-2

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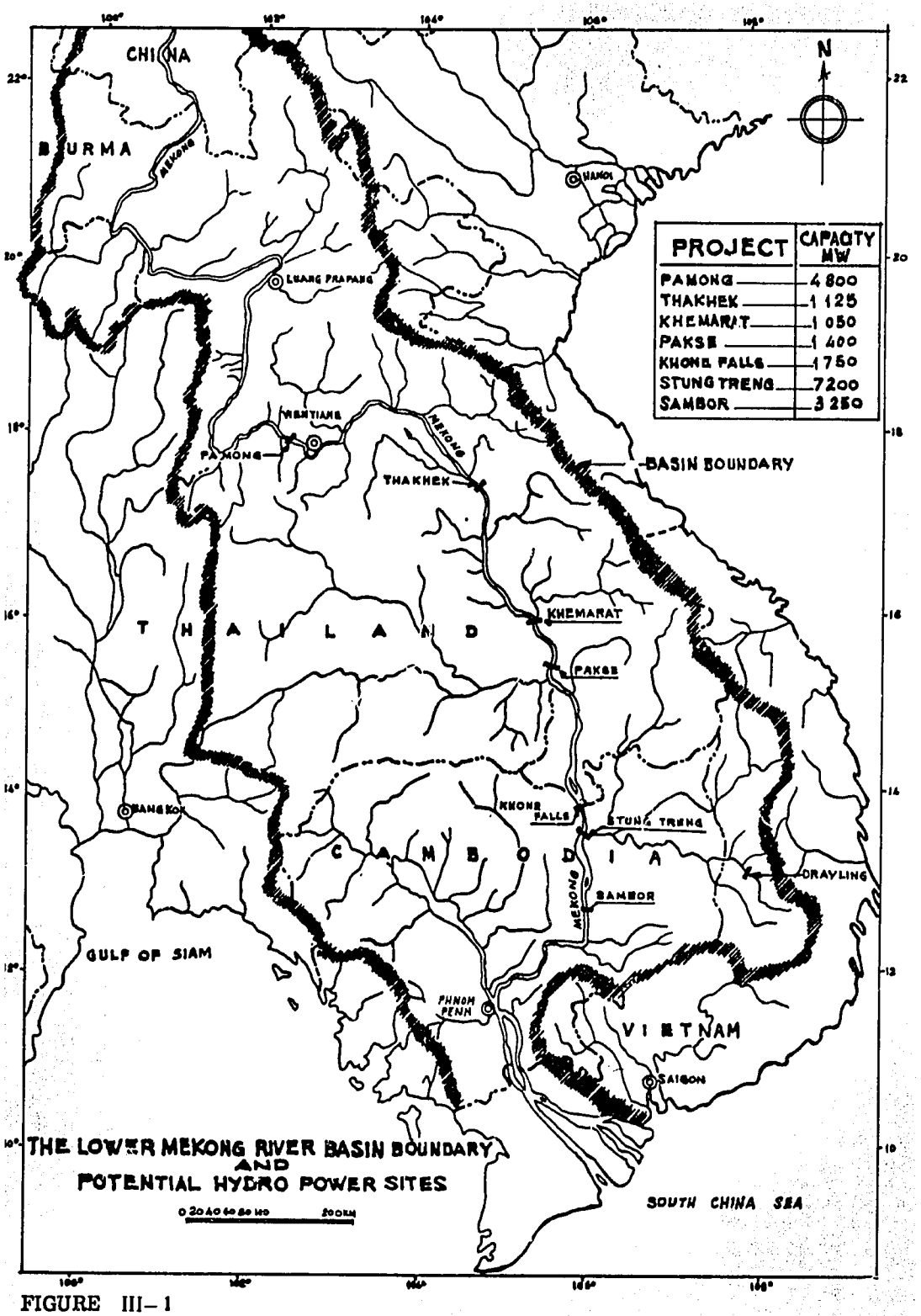

FIGURE III– 1

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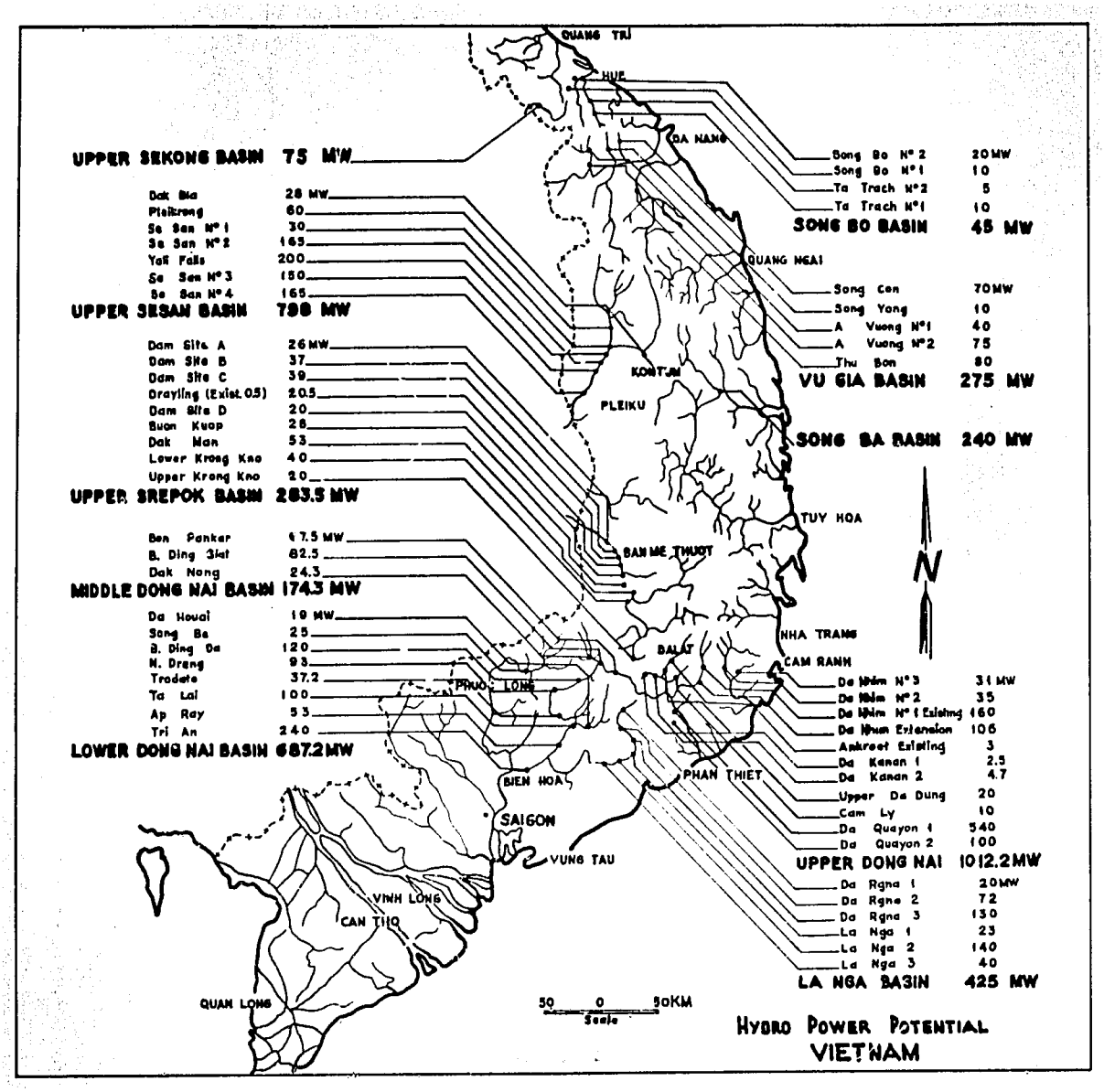

FIGURE III– 2

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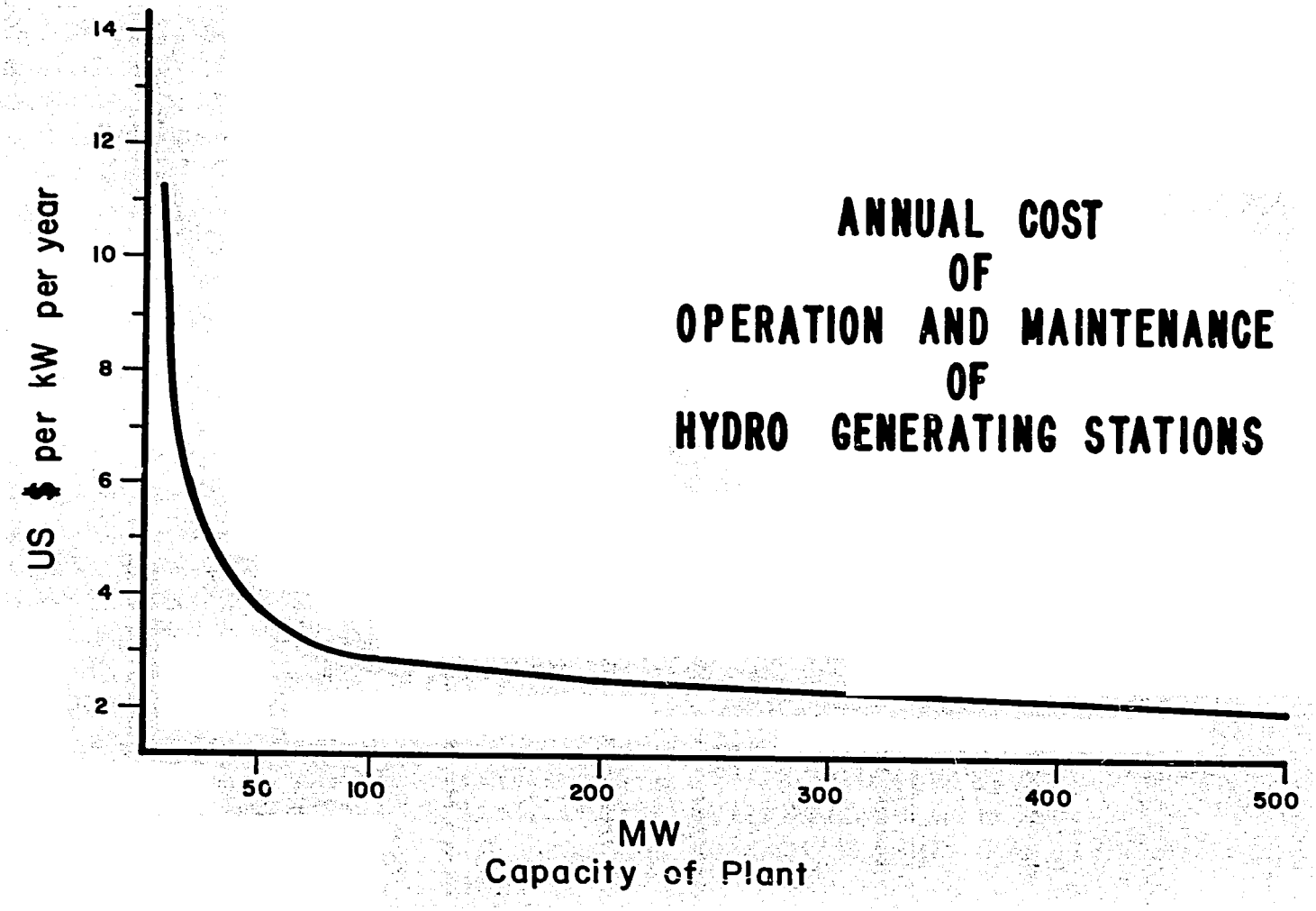
FIGURE III-3



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thermal generating units. In the case of the smaller isolated load centers, such as Ban Me Thuot, the alternate source of power would be large, heavy-oil type diesel generating units.

In evaluating capital costs of hydro and thermal plants, it was assumed that money would be available at six percent interest rates from such banks as Asian Development Bank (ADB), World Bank, and Export-Import Bank of Tokyo (EXIM Bank). Presently, US fund grants to GVN for use by VPC require interest payments to GVN of about six percent, which is about the present rate of borrowings by the US. Some funds have been made available to VPC by GVN and others at three percent. VPC has no basic foreign exchange authority, and all conversions for VPC for foreign exchange must be made by GVN. Thus, all loans made to VPC are guaranteed by GVN. It is expected that it will be necessary for GVN to continue such guarantees at least for the next 15 years in order to get the most favorable interest rates and thus hold foreign exchange requirements to a minimum.

Commercial loans are presently being made in Saigon at 18 to 24 percent, but it is not expected that funds from such sources would be used for major construction purposes.

Inflation may result in increased costs of construction and production of both hydroelectric and thermal generating stations, but both would be affected by approximately the same rates of inflation so the ratio of annual benefits to annual costs for the hydroelectric projects probably would not be changed substantially by future inflation.

Allocation of Capital Costs of Multipurpose Water Resources Development Projects

The development of water resources projects may provide national benefits, such as water for irrigation, flood control, navigation improvement, etc., in addition to electric power. These additional benefits should be assessed and taken into account in determining the economic feasibility of each project.

For example, the Song Ba project is a multipurpose project, the principal purpose of which is to provide a water supply for irrigation. It also would provide flood control and make it possible to develop 150 000 kW of power. In a preliminary report on this project, Nippon Koei proposed to allocate 47 percent of the cost of the common use facilities (An Khe dam and reservoir) to irrigation and 53 percent to power.

Regardless of whether the portion of the cost of the common-use facilities allocated to irrigation and flood control is borne by the water users or by GVN, an allocation of this kind is considered to be reasonable, proper, and essential since power cannot bear the total cost on a competitive basis. Even if a power installation at a multipurpose dam is economically feasible, if all of the cost is charged to power, an equitable portion of the cost of the common-use facilities should be allocated to other uses benefited. If such allocations are not made, a desirable potential power project may be eliminated or, if constructed, the cost of power would be higher than it should be which would be reflected in higher rates for electricity. Obviously, it is desirable to establish rates for power as low as practicable in order to stimulate industrial development.

Operation of Hydro And Thermal Generating Capacity

In general, it may be stated that a proper combination of thermal and hydro generating capacity will result in the lowest cost of energy. During wet periods, the hydroelectric plants can be operated to produce the maximum amount of energy consistent with load requirements from the available water supply.

During dry periods, the hydroelectric plants are operated so as to use the available water to produce on-peak power for a short period of time each day. The thermal plants then are utilized to supply base-load energy to meet the power system requirements.

During off-peak periods, when the water supply is sufficient only for production of on-peak power, the hydroelectric units can be used as spinning reserve for the power system at less cost than the reserve can be supplied by the thermal units as the latter have to generate some energy when operated as spinning reserve to prevent them from overheating. Such operation would result in reduced efficiency and increased cost. Figure III–4 indicates how the Da Nhim I hydroelectric generating station could be utilized during both wet and dry periods.

Most Vietnam hydroelectric projects are projects with limited storage capacity. During an average water year, much of the integrated load can be carried by these plants, but during periods of protracted dry spells, either thermal support or support from large storage-type hydroelectric plants is necessary.

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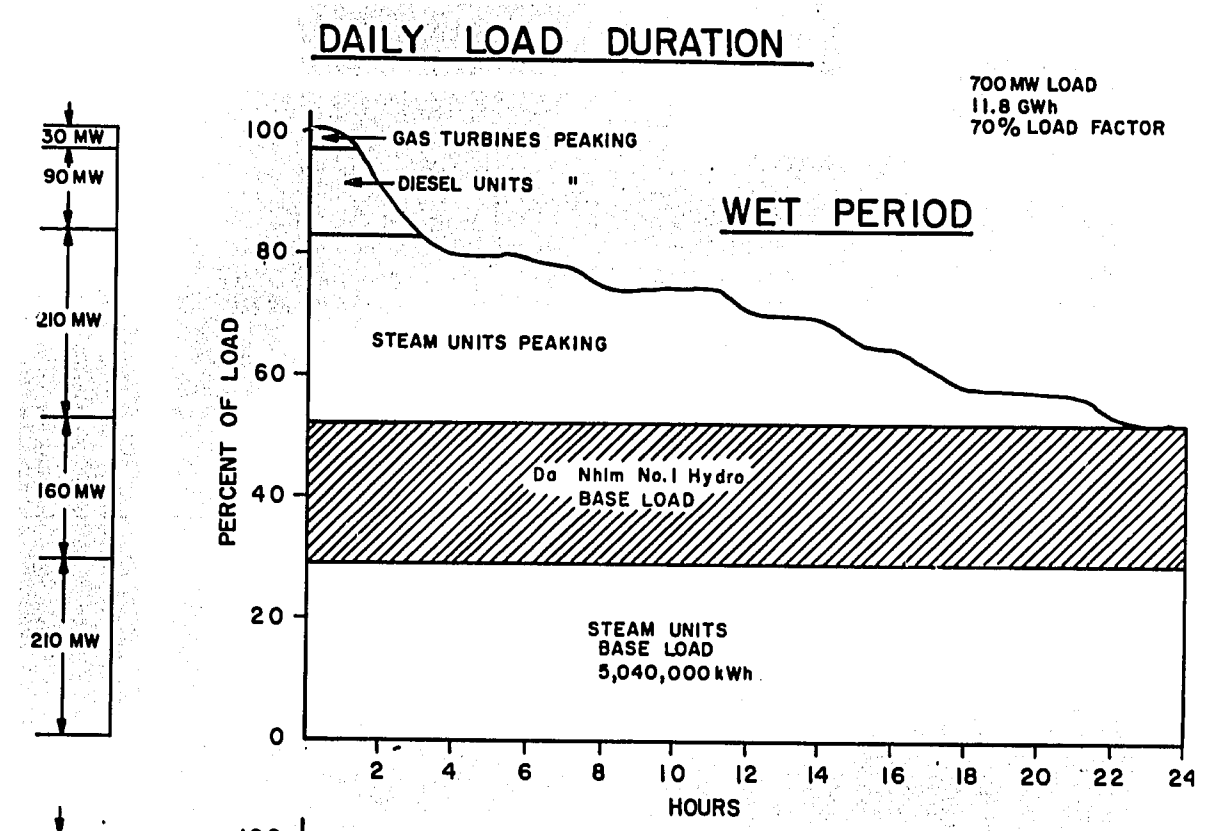

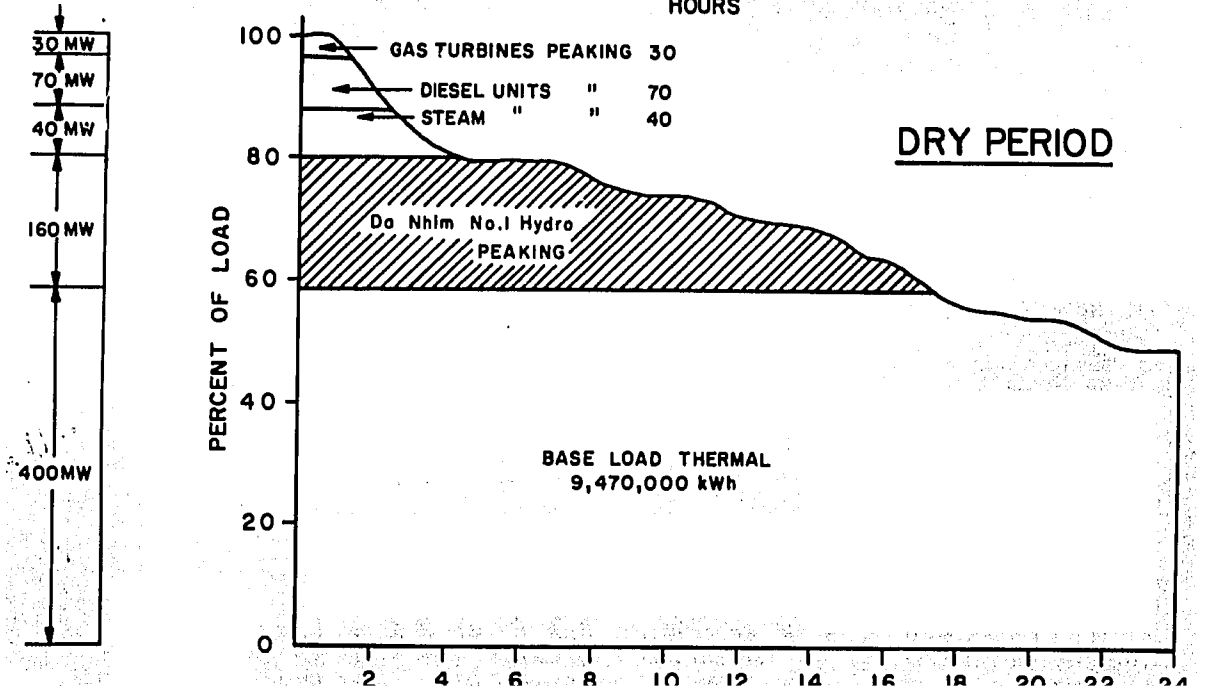

FIGURE III-4

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The Mekong River projects are very large hydro projects, many of which will have large storage capacity, but these projects will probably not be available within the next 15 years. As part of the present planning by the Mekong Committee, studies should be made as to the possibilities of using energy from the Mekong storage projects during dry spells on Vietnamese rivers with a subsequent payback of energy under suitable terms when Vietnam's river flows are above average. Such arrangements are common in the Columbia Basin in the US Pacific Northwest and over long distances between the Pacific Northwest and California, for example. The best use of the Mekong River developments and all the hydros in Vietnam will be to have them operate as part of an interconnected system embracing all of Indochina. National frontiers have yielded in many parts of the world to the economic advantages available in such relationships.

The irrigation needs of hydro plants may have a limiting effect on power production. Since very few irrigation projects have been programmed, it has not been possible to ascertain such effects. Irrigation benefits should be used not only to reduce the cost of power but also to assist in producing the best economic relationships when an integrated hydro system embracing the Mekong River developments is considered.

General Attributes of Hydroelectric Power in Vietnam

The factors involved in the development of water resources projects in Vietnam include:

(1) The large amount of capital funds required for construction.

(2) The length of time required for investigations, planning, preparation of designs, financing, and actual construction. Thermal generation can be constructed in less time than a hydro project and, in the early years, offers the only practical alternative in meeting the pent-up loads.

(3) The lack of adequate hydrological data which makes the determination of the amounts of power and energy that can be produced uncertain. This comment applies to most of the potential hydroelectric power projects in Vietnam. It has not been possible to construct access roads and make field investigations of some of the more attractive potential hydroelectric power projects in Vietnam because of lack of security. This problem will be overcome when the war is over.

The advantages of developing the water resource projects are many. They include:

(1) The water resources are inexhaustible.

(2) The cost of operation is low compared to thermal generation as no fuel is required.

(3) The net saving in foreign exchange which may result from the production of energy by hydro generation rather than by thermal energy which requires the importation of fuel. Any saving is of importance to Vietnam where foreign exchange is urgently needed for rehabilitation and development. Factors which must be considered and which are offsetting to an important degree include the foreign exchange requirements for payment of interest on the greater capital cost per kilowatt of hydro plants as compared to thermal plants, and the foreign exchange requirements for the amortization of loans under the present method of financing which approximate the foreign exchange requirements for fuel after 1980.

(4) Hydroelectric projects frequently can be designed to include space for additional generating units to be added at some time in the future at relatively low cost. Thus, on-peak power can usually be added at lower cost from existing hydro plants than it can be from new thermal generation.

(5) Several of the potential water resources projects not only would produce low-cost hydroelectric energy but they also would provide a water supply for the irrigation of large areas of arable lands. This is especially important in Vietnam where a large part of the population is engaged in agriculture and where there is an ever-increasing demand for food and fiber.

(6) Construction of the dams, generating stations, and transmission lines would provide employment for a large work force. This may be highly desirable in the postwar period when many men who are in the armed forces will return to civil life and need employment.

(7) Hydroelectric plants do not have air pollution problems and usually enhance the area in which they are built. There may be problems relating to fish life but they can be solved.

Description of Potential Hydroelectric Projects

Following are brief descriptions of the potential hydroelectric projects which have been reviewed and considered for inclusion in the suggested power development program.

Da Nhim Hydroelectric Project – The Da Nhim River is one of the larger upstream tributaries of the Da Dung which, in turn, is a tributary of the Dong Nai, the largest river in Vietnam. The catchment area of the Da Nhim is at an elevation

of 1018 m or higher. A narrow ridge on the eastern side of the basin separates it from the coastal plains which are at an elevation of about 40 m where the water discharged from the proposed Da Nhim 3 generating station enters the plains. The ridge drops precipitously on the eastern side. There are a number of possible reservoir sites in the Da Nhim basin, the combined storage capacity of which is sufficient to regulate the flow of the Da Nhim and its tributaries so as to produce a uniform discharge of about 32 m^3/s. By diverting this discharge from the Da Nhim basin through the narrow ridge and utilizing the drop of about 1000 m, a total of about 330 000 kW could be developed.

The Da Nhim 1 generating station, with an installed capacity of 160 000 kW, was completed in 1964. It is planned to develop the remaining potential power in three generating stations comprising the Da Nhim Extension to the No. 1 generating station with an installed capacity of 106 000 kW, the Da Nhim 2 generating station with an installed capacity of 35 000 kW, and the Da Nhim 3 generating station with an installed capacity of 31 000 kW. The principal features of the Da Nhim projects are summarized in the tabulation below.

The Da Nhim Extension project, as the name implies, is an extension to the existing No. 1 generating station. However, the water supply for the extension project will be independent of that of the existing No. 1 generating station, and the operating head of the extension project will be lower than that of the existing station.

The principal features of the extension project include two storage reservoirs on the Da Nhim. The Lien Khang reservoir is the larger of the two with a gross storage capacity of 207 million m^3. It is to be created by construction of an earth-fill dam on the Da Nhim, 47 m in height, with a gate controlled overflow spillway. A concrete weir, 4 m in height, on the Da Tam will divert the water of that stream through a short diversion channel to the Lien Khang reservoir. The second reservoir, called the Trom Loh, will be created by a rock-fill dam across the Da Nhim at the upstream end of Lien Khang reservoir. It will have a gross capacity of 100 million m^3. When full, the elevation of the water surface in both reservoirs will be the same, and water from the downstream reservoir will flow by gravity into the upper reservoir. When the water surface in the downstream reservoir is lower than that in the upper reservoir, water will be lifted by pumping from the lower reservoir into the upper reservoir. The pumping station will operate under heads varying from zero to 32.4 m and will have a discharge capacity if 17.7 m^3/s. It will have an installed motor capacity of 3 700 kW. The pumping plant is designed so that pumping can be done during off-peak periods thus making the full capacity of the generating station available during peak periods.

A pressure tunnel, 2.8 m in diameter and 10394 m in length, will carry the stored water from the upper end of Trom Loh reservoir to a surge tank at the upper end of a single penstock, 2.5 to 0.91 m in diameter and 2300 m in length, which will bifurcate at the lower end and lead to two impulse-type water turbines directly connected to two horizontal generators of 53 000 kVA each. The net operating head will be 718 m. After supplying 13 GWh for the operation of the Trom Loh pumping station, the net average annual output of the Da Nhim Extension generating station will be 742 GWh. The water discharged from Da Nhim 1 generating station will be conducted to the No. 2 generating station which is to have an installed capacity of 35 000 kW and thence to the No. 3 generating station which is to have an installed capacity of 31 000 kW.

	Da Nhim 1	Da Nhim Ext	Da Nhim 2	Da Nhim 3	Total
Gross head – m	799	759	110	87	–
Net head – m	748	718	95	79	–
Discharge – m^3/s	18	14	32	34.8	34.8
Installed capacity – MW	160	106	35	31	332
Dependable capability – MW	160	99.5	35	31	325
Annual energy – GWh	1 026	755	234	206	2 221
Energy for pumping – GWh	–	(13)	–	–	(13)
Net energy – GWh	1 026	742	234	206	2 208
Estimated cost as of 1971 – US$M	39.2*	48	19	15.9	122.1

Recorded cost, exclusive of transmission line and Saigon terminal substation.

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After leaving the No. 3 generating station, the water will be available for irrigating some 22 000 hectares of arable land in the Phan Rang plains area.

The Da Nhim Extension project has a favorable ratio of annual benefits to annual costs and is economically feasible.

Final detailed designs for the project have been prepared by Nippon Koei. Construction could be started as soon as the project has been authorized and arrangements have been made for financing the cost. The project would take about four years to complete.

Da Quayon Hydroelectric Project – The Da Quayon River is one of the larger tributaries of the Da Nhim which joins the Da Dung to form the Dong Nai, the largest river in Vietnam. The proposed Da Quayon project is a multipurpose project which, when fully developed, would produce 640 000 kW of power and a water supply for the irrigation of 45 000 hectares of arable lands in the Phan Ri and Phan Thiet plains area.

The general plan for the project, as visualized in a preliminary planning report prepared by Nippon Koei dated November 1965, includes a large reservoir on the Da Quayon and five smaller reservoirs on the Da Kanan, Da Dung, and Cam Ly rivers. The total storage capacity of these reservoirs would amount to about 800 million m^3 sufficient to produce a regulated discharge of about 65.7 m^3/s.

The waters from the smaller reservoirs would be diverted by gravity to the proposed Bon Ron reservoir on the Da Nhim from which the water would be lifted by pumping into the Da Quayon reservoir. A narrow ridge along the southern rim of this reservoir separates it from the coastal plain. This ridge drops precipitously on the southern side so that by diverting the water from the reservoir by tunnel through the ridge, a drop of about 840 m can be developed for power production.

The project could be constructed in three stages. The principal features of each stage are summarized in the tabulation below.

In the preliminary plan for the Da Quayon project, the pumping plant requires a maximum of 88 000 kW for its operation which has to be deducted from the power produced by the No. 1 generating station leaving a net output of 452 000 kW. It is suggested that when final designs are prepared, the pumping plant be designed so that pumping can be done during off-peak periods in order that the full capability of the generating station will be available during on-peak periods. It would appear that 88 000 kW of peaking capacity could be obtained in this manner at relatively low cost per kilowatt.

The 55 m^3/s of water discharged from the Da Quayon generating station will be available for the irrigation of arable lands in the Phan Ri and Phan Thiet plains.

The Da Quayon project has a favorable ratio of annual benefits to annual costs indicating that it is economically feasible. It is suggested that an appropriate amount of the capital cost of this project be allocated to irrigation in order to reduce the cost of power.

While considerable field investigation has been done on this project, additional work remains to be done before final designs can be prepared. This work should be started as soon as security conditions will permit in order that the first stage can be completed in time to supply the increase in load on the interconnected power system following completion of the Da Nhim Extension project and thus avoid having to construct another large thermal generating unit early in the power development program.

The general arrangement of the hydro projects on the Da Nhim and Da Quayon rivers are shown

	No. 1 Stage 1	No. 1 Stage 2	No. 2	Total
Gross head - m	701	701	138.5	839.5
Net head - m	675	675	127.5	802.5
Discharge - m^3/s	-	-	65.7/62.5	65.7/72.5
Installed capacity - MW	270	270	100.0	640.0
Dependable capacity - MW	228	206	100.0	534.0
Annual energy - GWh	1 830	1 519	653.0	4 002.0
Pumping energy - GWh	(282)	(318)	-	(600.0)
Net energy - GWh	1 548	1 201	653.0	3 402.0
Estimated cost as of 1971 - US$ M	103	43.7*	44.6	191.3

Small generating stations at Da Kanan No. 1 and Da Kanan No. 2, Upper Da Dung, and Cam Ly dams omitted. Power from these generating stations is seasonal in nature; therefore, the energy is only useful as fuel replacement.

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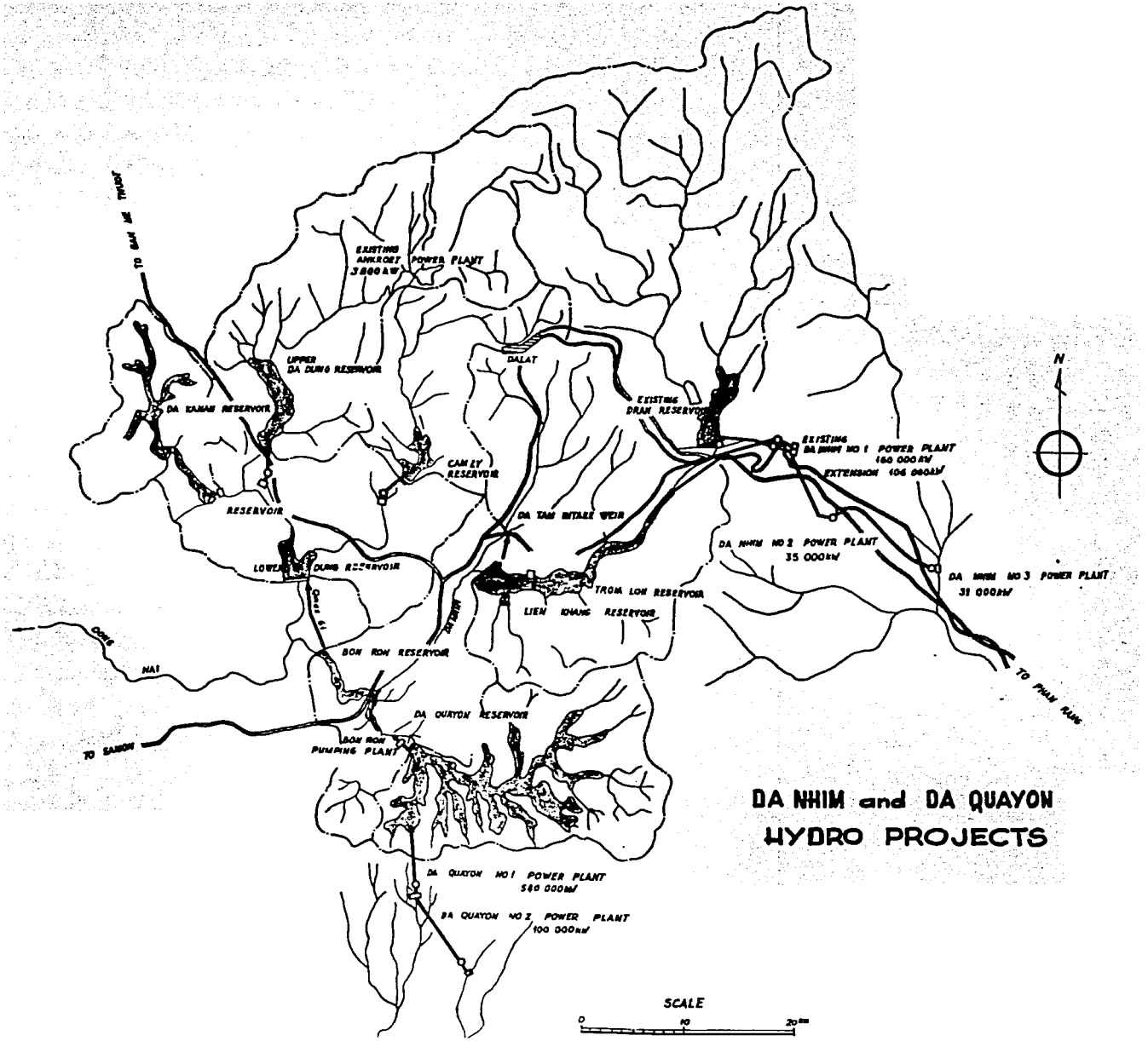
DA NHIM and DA QUAYON
HYDRO PROJECTS
EXISTING AMKROET POWER PLANT 3 800 kW
UPPER DA DUNG RESERVOIR
DA KAMAH RESERVOIR
RESERVOIR
LOWER DA DUNG RESERVOIR
CAM LY RESERVOIR
DALAT
EXISTING DRAN RESERVOIR
DA TAM BITAKE WEIR
TRONG LOH RESERVOIR
LIEN KHANG RESERVOIR
BON RON RESERVOIR
DA QUAYON RESERVOIR
BON RON PUMPING PLANT
EXISTING DA NHIM NO 1 POWER PLANT 160 000 kW
EXTENSION 106 000 kW
DA NHIM NO 2 POWER PLANT 35 000 kW
DA NHIM NO 3 POWER PLANT 31 000 kW
DA QUAYON NO 1 POWER PLANT 540 000 kW
DA QUAYON NO 2 POWER PLANT 100 000 kW
TO PHAN RANG
TO SAIGON
NAI
N
SCALE
0
10
20 km

FIGURE III–5

on Figure III-5.

Tri An Hydro Project – The Tri An project is located on the Dong Nai, a short distance above the confluence of the Dong Nai and the Song Ba. It is about 60 km northeast of Saigon.

Preliminary desk studies have been made of the project by Sofrelec of France, Nippon Koei, and VPC. The surface geology at the dam site has been studied, but no subsurface explorations have been made.

As visualized in the preliminary studies, the project would comprise a main concrete dam of the overflow-spillway type, about 38 m in height, across the Dong Nai at the head of a rapids section and a smaller dam, 35 m in height, of the earth-fill type across a small tributary of the Dong Nai. These dams would create a reservoir having a gross storage capacity of about 1 200 million m^3. The total head available for power generation would vary from 43 to 41.5 m.

The preliminary studies of the hydrology of the Tri An, based on meager hydrological data, indicate that there is sufficient water for an ultimate installation of 240 MW of generating capacity and that the average annual energy output would be about 67 GWh.

The estimated capital cost of the first stage (120 MW) of the project, excluding transmission facilities to connect it with the Saigon load center, is US$50 million. The cost per kilowatt of installed capacity is US$417. The preliminary estimate indicates that the project would be economically feasible.

The preliminary plan for the Tri An hydroelectric project contemplates an ultimate installed capacity of 240 000 kW to be used for peaking purposes. Such operation would cause wide daily fluctuations in stream flow below the generating station which may adversely affect the operation of the Saigon water intake and may aggravate the salt water intrusion problem during low stream flow periods. These problems should be thoroughly investigated when final plans are made for this project.

This project, being located in close proximity to Saigon and having a large capacity reservoir, would be well suited to provide on-peak power for the interconnected power system provided the problems mentioned above can be solved.

Lack of adequate security has prevented making complete investigations of the project. This work should be started as soon as security will permit. River gaging station should be established and maintained so as to have additional hydrology data available for final design and operation of the project.

Considering the time that will be required to make the necessary field investigations, prepare final designs, arrange project financing, and construct the project, it appears that about six years would be required to complete the project.

La Nga and Da Rgna Hydro Projects – The proposed hydroelectric developments on the La Nga and its tributary, the Da Rgna, are located about 85 km northeast of Saigon.

Lack of security has prevented field investigations of the potential power possibilities; however, a preliminary study was made in 1966 by Nippon Koei using maps made from aerial photographs of 1 to 20 000 scale for the downstream portion of the basin and 1 to 50 000 scale for the upper portion. The study proposed three dams, storage reservoirs, and generating stations on the Da Rgna, and three dams, storage reservoirs, and generating stations on the La Nga.

The projects could be constructed in stages as needed to meet the power requirements. The first stage could consist of the No. 2 and No. 3 generating stations on the La Nga with 70 MW installed in the No. 2 station and 20 MW installed in the No. 3 station. Ultimate installations would be 140 and 40 MW, respectively. The No. 3 project would provide a water supply for irrigation and some flood protection for downstream areas. The first stage would produce about 517 GWh in an average year. The estimated cost of the first stage development is US$45.2 million. The remainder of La Nga and the Da Rgna projects would have an installed capacity of 476 MW.

The preliminary studies of the La Nga projects indicate that they may be feasible but more investigations are needed and they should be made as soon as security conditions in that area will permit. River gaging stations should be established and maintained at each of the proposed power sites in order to obtain as much data on stream flows as possible as a basis for final planning and design.

The La Nga power projects are included in the proposed power development program on the assumption that they will be found to be feasible when fully investigated.

Song Ba Multipurpose Project – The Song Ba or Binh Dinh water resources development is a multipurpose project intended to provide a supplemental supply of water for the irrigation of about 53 000 hectares of cultivated land in the Qui Nhon plain and to develop about 150 MW of hydroelectric power by diverting water from the Song Ba to the Song Kone. The project is located about 60 km northwest of the city of Qui Nhon.

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A preliminary design report on the proposed irrigation and power project was prepared in 1969 by Nippon Koei. The proposed development includes an earth-fill dam, 34 m in height, on the Song Ba which would create a storage reservoir having a gross capacity of about 500 million m^3. Water from this reservoir would be diverted through a tunnel to the Song Kone. After leaving the tunnel, the water would drop about 400 m to the generating station. The installed generating capacity would be 150 MW, the dependable capability would be 138 MW, and the average annual energy output would be about 868 GWh.

The estimated cost of the power feature, including the total cost of the An Khe dam and reservoir, exclusive of the irrigation features and transmission lines, is about US$60 million. Nippon Koei proposed that 47 percent of the cost of the An Khe dam and reservoir be allocated to irrigation and 53 percent to power.

The preliminary estimates indicate that the proposed An Khe hydro power project would be economically feasible.

Construction of the An Khe dam would require about three years after completion of final designs and financial arrangement. The An Khe generating station could be built concurrently with construction of the An Khe dam or postponed until later, depending upon the need for power in the Qui Nhon and Cam Ranh areas. Power from this project could be transmitted to Kontum and Pleiku by constructing about 120 km of transmission line. About 290 km of 230-kV transmission line would be required to connect the Song Ba hydro plant with the main transmission system at Cam Ranh.

Upper Se San Hydro Projects – The upper Se San project is located on the Se San River in the northwestern part of Vietnam in the general vicinity of Kontum and Pleiku. It is about 150 km northwest of Nha Trang. The Se San is one of the major tributaries of the Mekong River.

The possibilities for development of the potential hydro power of the upper Se San were studied by Nippon Koei in a report to the Mekong Committee in 1966. These preliminary studies indicate that the water resources of the Se San in Vietnam have a potential of some 800 MW.

The most attractive hydro site on the upper Se San is at Yali Falls where there is a natural drop of 40 m in the stream. This site is located about 30 km southwest of Kontum. It would be possible to develop a total of 200 MW at this site by constructing a dam, 33 m in height, across the river just above the falls and a generating station located a short distance below the falls. This is too large a block of power to be absorbed by the local markets; therefore, it appears that the full development at Yali Falls will not be made until some time in the future. In view of this situation, Nippon Koei proposed that a small hydro plant with an initial installation of 6 MW, which could be increased to 12 MW when additional power is needed, be built to supply the local demand for power in the Kontum and Pleiku areas.

Estimates of the load in Kontum indicate that the 6-MW hydroelectric plant would suffice for possibly ten years after which the second generating unit would be required. The small power development would cost about US$5 million, exclusive of the cost of distribution facilities in Kontum and Pleiku. The 12 MW hydro plant would be competitive with the cost of diesel engine generation operating on heavy fuel oil. If the small hydro plant is replaced by construction of the larger hydro plant (200 MW) before the investment has been amortized, it probably would be more economical to employ diesel engine generation to supply the local power requirements until the larger hydro plant is constructed.

The full development at Yali Falls, as proposed by Nippon Koei, could be constructed in two stages of 100 MW capacity each. The estimated costs and output of power and energy are shown in the following tabulation:

Installed capacity – MW	200
Annual energy – GWh	672
Capital cost – US$M (exclusive of transmission)	55
Cost per kW – US$	275

The preliminary investigation of the Yali Falls hydro project indicates that it would be feasible economically if connected to the main transmission grid making it possible for the total output to be utilized.

This project has a lower ratio of benefits to costs than the Song Ba project if 43 percent of the cost of the common-use facilities of the latter project is allocated to irrigation. Furthermore, the Song Ba power project is located nearer to the proposed main transmission grid. In the proposed power development program, it is assumed that the Song Ba multipurpose project will be constructed prior to the Yali Falls project. When the Song Ba project is completed, the power requirements of Kontum and Pleiku could be supplied by construction of a transmission line about 120 km in length from the Song Ba project. This arrangement would appear to be more economical than constructing the small hydroelectric

generating plant at Yali Falls which would be abandoned when the larger hydro plant is built.

Drayling Hydroelectric Project – The proposed Drayling hydroelectric project is located on the Eakrong River at Drayling Falls where a natural drop of 13 m exists in the stream. The site is about 17 km west of the city of Ban Me Thuot.

A small hydroelectric plant of 480-kW capacity is in operation at the site but its output is insufficient to supply the local demand for power and some 1200 kW of diesel generating capacity is in service supplementing the hydro output. The diesel units operate on high cost light oil resulting in high cost of electricity. Furthermore, the supply of power is inadequate to meet the demand and additional generation is urgently needed.

The plan for developing additional hydroelectric power at Drayling Falls was investigated by Nippon Koei in 1962. Its report indicated that it would be feasible to construct a larger hydro generating station with an initial capacity of 4000 kW and an ultimate capacity of 12 000 kW. EOV restudied the project in 1964 and prepared a feasibility report and specifications for the generating station, 66-kV transmission line to Ban Me Thuot, and a substation at the latter point.

The cost of the proposed project with an installed capacity of 8000 kW and including transmission and substation facilities, was estimated in 1969 as US$5 362 000. Allowing for escalation of construction costs which has occurred since the estimate was made, the cost estimate for an installation of 12 000 kW, exclusive of transmission facilities, should be increased to about US$5.5 million based on present day construction costs. It probably could be completed two years after authorization.

Construction of the proposed hydroelectric generating station would provide a dependable supply of low-cost power which would be adequate for the local requirements in the Ban Me Thuot and contiguous areas for a decade or more. It is expected that eventually a transmission line will be built to connect Ban Me Thuot with the main interconnected transmission grid at Nha Trang or Dalat.

The cost of power produced by the hydro generating plant would be lower than the cost of equivalent amount produced by heavy-oil type diesel engine generation.

Estimates of load growth in the Ban Me Thuot area made by VPC indicate that the demand for power would reach 8 000 kW about 1975, assuming that adequate generating capacity and transmission and distribution facilities are provided to supply the demand.

The Drayling hydroelectric project is included in the proposed power development program. It is recommended that the project be authorized and that its construction be initiated as soon as arrangements for financing the cost can be made.

Thu Bon Hydro Project – The Thu Bon project is located on the Thu Bon River approximately 55 km southwest of Da Nang. It is a multipurpose project which would provide much needed flood control, a water supply for irrigation, and, when fully developed, would produce about 80 MW of power. Preliminary studies based on very meager hydrological data indicate the dependable capability in dry periods would be about 47 MW and, in an average year, the output would be about 323 GWh.

The capital cost of the project, exclusive of transmission facilities, was estimated at US$31.6 million in 1965 by the former EOV. The 1971 escalated cost is estimated at US$41.2 million.

In 1963, an effort was made to establish a stream gaging station on the Thu Bon River near the site of the proposed hydro project and to make a detailed survey of the dam site and reservoir area but the field work had to be discontinued due to lack of security. This work should be resumed as soon as security conditions will permit in order to obtain the necessary information for preparation of a feasibility report and for final planning.

The regulated flow provided by the storage reservoir would serve to irrigate some 100 000 hectares of arable lands in the vicinity of Da Nang.

Preliminary study of the project indicates that it would not be feasible economically unless a substantial part of the cost of the joint-use facilities is allocated to irrigation and flood control.

The Song Bo Hydro Project – The Song Bo project is located on the Song Bo River approximately 20 km west of Hue. The project has not been investigated but very preliminary examination indicates that a power development of about 20 MW may be possible. This project should be investigated when security conditions will permit access to the area to ascertain whether it has technical and economic feasibility.

Neither the Thu Bon nor the Song Bo project is included in the 15-year suggested power development program.

Minor Hydro Plants – Two small hydroelectric plants were included in the short-range development plan proposed by VPC. The Song Be project, with a capacity of 4000 kW, is located at Phuoc Binh and the Danknong project with a

capacity of 3000 kW is located at Gia Nghia, Phuoc Long. Both of these small generating stations are intended to supply power to the local isolated areas where they are situated. The estimated cost of these projects is US$5 million.

In view of the high cost of these small hydroelectric plants, it appears that the localities could be supplied more economically by diesel generating units until such time as the power requirements increase sufficiently to justify the construction of transmission lines to supply power from the main interconnected power system. Neither of these small hydro plants has been included in the suggested development program.

Sequence of Construction of Hydroelectric Projects

The sequence in which the various hydro projects are placed in the suggested power development program is as follows:

Order of Construction	Project	Date in Service
1	Da Nhim Extension	6–76
2	Da Quayon 1, Stage 1	6–78
3	Da Quayon 1, Stage 2	6–79
4	Da Quayon 2	1–80
5	Tri An	1–80
6	La Nga 2 & 3, Stage 1	1–83
7	Song Ba	1–84
8	Yali Falls	1–85

The small Drayling hydroelectric project is scheduled to go into service in 1974 to serve the isolated load at Ban Me Thuot and vicinity. It is expected that eventually Ban Me Thuot will be connected to the main interconnected power system.

The Da Nhim Extension project has been selected as the first hydro project to be constructed because it has been investigated and is ready for construction as soon as it is authorized and financing has been arranged. It could be completed sooner than any of the other hydro projects which is important as early completion may defer the installation of additional thermal generating capacity. The site is readily accessible. The project is feasible both technically and economically. The cost of operation will be relatively low due to the location of the generating units in the No. 1 generating station thus utilizing the same operating staff. The project will provide additional water for irrigation of some 22 000 hectares of arable lands in the Phan Rang plains area.

The Da Quayon project has been selected for the second hydro development. This project has been investigated and is ready for final planning. In view of the preliminary investigations that have been made, actual construction could be started sooner than other hydro projects such as Tri An and La Nga which have not been investigated in the field. Like the Da Nhim Extension project, the Da Quayon project will provide additional water for irrigation in the Phan Ri and Phan Thiet coastal plains.

The Tri An project has been selected to follow the Da Quayon 2 generating station in order to provide sufficient time for field investigations, planning, and design. This is a desirable project due to its location in close proximity to the Saigon-Cholon load center. Preliminary desk studies of the Tri An project indicate that it is technically and economically feasible.

The first stage of the No. 2 and No. 3 La Nga hydro projects has been scheduled to follow the Tri An project. These projects have not been investigated in the field due to lack of security in that area, but desk studies indicate that they may be found to be feasible.

The Song Ba multipurpose project has been scheduled to follow the La Nga project and the Yali Falls project, has been scheduled to follow the Song Ba project.

The order in which the hydroelectric projects are constructed may be changed, particularly in the latter part of the program, as may be found desirable upon more complete investigations and further planning to meet the additional requirements for power. The important thing is to complete the field investigations and planning of several of the more attractive potential hydro projects so that an orderly and economical power development program can be followed.

NUCLEAR ENERGY

No exploration for uranium or other nuclear minerals has yet been carried out in Vietnam. A prospecting program was planned in 1959 but the actual search for nuclear minerals has not yet been made. According to the Preliminary Assistance Mission of the International Atomic Energy Agency, the age of rock formation and the association of rock types suggest that Vietnam may have good prospects for uranium and other minerals such as beryllium and niobium.[2]

At the present state of development of the art

[2]EOV, *Energy Resources and Their Utilization in Vietnam.* GVN, 1965.

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of nuclear power generation, the nuclear power generating units have to be of large capacity, on the order of 500 000 kW or more, to be competitive with fossil fuel generation. It will be after 1986 before units of this size can be justified on the VPC system because of the large amount of reserve capacity that would be required to supply the demand for power during periods when the nuclear reactors have to be taken out of service for refueling which may require a month or more.

By the time VPC will be in a position to consider nuclear power, the art of generating power from the atom will have progressed well beyond the frontiers of today. The competitive relationship between nuclear power and potential hydroelectric projects in Vietnam and on the Mekong is impossible to predict at this time. It can be stated that Vietnam is fortunate to be able to look forward to consideration of low-cost hydroelectric power and a more advanced stage in the art of nuclear generation in making selection for additional generating capacity after 1986.

SECTION IV
HISTORY OF ELECTRIC POWER INDUSTRY

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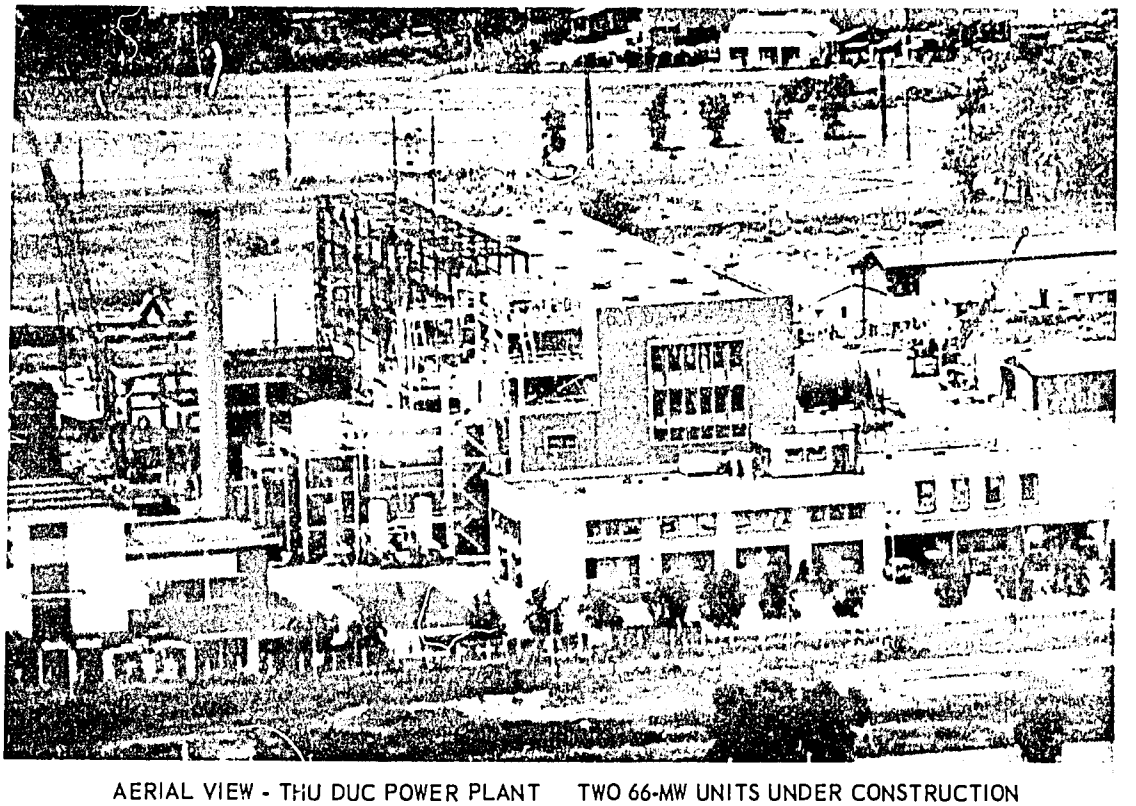

AERIAL VIEW - THU DUC POWER PLANT TWO 66-MW UNITS UNDER CONSTRUCTION

SECTION IV

HISTORY OF ELECTRIC POWER INDUSTRY

The early history of the electric power industry in Vietnam is closely related with the French Colonial government in French Indochina. During the 1920's and 1930's, special permits were granted to a number of French companies to generate and distribute electricity. In 1932, special 35-year concessions were granted to the Compagnie des Eaux et d'Electricite de l'Indochine (CEE) to operate in the Saigon-Dalat area, the Societe Centrale d'Eclairage et d'Energie (SCEE) to operate in the western provinces, and the Union Electrique d'Indochine (UNEDI) to operate in the middle west provinces and districts of Vung Tau and Phan Thiet. In 1940, SIPEA was granted a franchise to operate until December 31, 1975 in the coastal provinces of central Vietnam.

During the Japanese occupation, 1943–45, the French companies were permitted to operate the electric facilities under military control. Following the surrender, the French companies regained control and continued.

Following the creation of Vietnam by the Geneva treaty in 1954, these companies were able to retain their concessions. In 1958, GVN formed an Office National de Re-Equipment des Installations de Production et de Distribution d'Energie Electrique (ONDEE) to take charge of and develop certain power operations at Ankroet (1958); Qui Nhon and Ban Me Thuot (1959); Quang Ngai and Tuy Hoa (1960); Vinh Long (1961); and My Tho (1962). In 1959, the Da Nhim Authority was organized and GVN negotiated the building of the Da Nhim hydroelectric plant and transmission line at comparatively small cost to GVN using Japanese war reparation funds. CEE, realizing that GVN would soon be in the power business, was reluctant to advance money for additional generating facilities in Saigon. As a result, only expenditures were made for distribution, and power was purchased from GVN agencies.

The Da Nhim hydroelectric plant, started in 1959 and completed in 1964, was built at a cost of US$37.1 million from the Japanese war reparation funds. The 230–kV line and Saigon Substation were partly financed from the fund and partly by a loan from the EXIM Bank at a cost of US$5.4 million and US$5 million, respectively. The first unit (33 MW) at Thu Duc steam station was constructed at a cost of approximately US$12 million including the 66–kV loop around Saigon and associated substations.

EOV was formed in 1964 to combine all existing government power such as ONDEE, the Da Nhim Authority, Thu Duc project, etc., under a single administration. During the period 1964 through 1967, when the three French concessions, CEE, SCEE, and UNEDI expired. EOV mainly operated power generating facilities but did serve some outlying suburban areas. CEE continued to operate in the Saigon and Dalat areas, SCEE in the western provinces, and UNEDI in the middle west provinces and the districts of Vung Tau and Phan Thiet until 1967 when they were taken over by SPC and EOV.

In 1967, SPC was organized to take over the CEE operations in the Saigon area. EOV and SPC operated various properties until 1969 when they were merged into a new government-owned company named the Vietnam Power Company.

During 1967, the US government approved a US$32 million grant to GVN. These funds were loaned by GVN to VPC for engineering and construction of two 66–MW steam generating units at the Thu Duc station and the extension of the 66/15–kV system in the Saigon metropolitan area. This work is scheduled for completion during 1972.

In May 1965, the 230–kV transmission line from Song Pha (Da Nhim hydro) to Saigon was damaged by enemy action in the Long Khanh province; since then, the hydroelectric station only supplied power to Dalat and surrounding districts. In November 1967, the two penstocks to the station were damaged, and the plant ceased providing power.

Security problems delayed completing negotiations with Japan for rehabilitation work until early 1970 when the Japanese Government agreed to set aside US$3 million for the work. This work is scheduled for completion during 1972 and 1973 (first and second stage). The 230–kV line repairs are scheduled during 1972 and 1973 depending on improved security.

Since the merger, VPC has been confronted with many problems. Some of the more urgent include combining the operations of EOV and SPC,

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developing a management and technical staff, providing additional generating capacity for all of Vietnam, developing expansion plans for taking care of the pent-up demand, arranging for funds to cover the needed equipment, and developing a new and modern accounting system.

However, with the help of USAID and outside consultants, the company has made progress. It developed a ten-year plan late in 1970 and has recently submitted a five-year development plan. This plan has been reviewed and is discussed under Section VI.

In September 1971, VPC negotiated a US$16 million loan from Japan. This loan is to cover engineering and construction of a first stage 33–MW steam generating plant at Can Tho together with a subtransmission system connecting province chief towns Long Xuyen, Rach Gia, Vinh Long, and Sa Dec. This project is scheduled for completion in 1974.

The future of the electric power industry in Vietnam hopefully will follow the successful patterns experienced in other undeveloped countries.

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SECTION V
POWER LOADS

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SECTION V

POWER LOADS

EXISTING SITUATION

The total existing capacity from all sources in Vietnam in 1970 was 760.9 MW as shown below.

Existing Generation Available in Vietnam
December 31, 1970

	MW		
Saigon Metro – VPC			
Steam	68.6		
Diesel	128.8		
Gas Turbine	27.5		
		224.9	
Hydro – VPC			
Drayling, Ankroet, etc.		2.5	
Provinces – VPC			
Diesel		45.5	
Provinces – Private			
SIPEA	25.7		
Industry	5.0		
GVN	13.0		
US Government	1.0		
Other	1.0		
		45.7	
Saigon – Private			
Industry	106.0		
GVN	1.5		
US Government (nonmilitary)	9.8		
		117.3	
US Military			
Vietnam		325.0	
TOTAL			760.9

The total installed and available generating capacity and gross and net generation at the end of 1970 are shown on Table V–1, and the net system input at the end of 1970 is shown in Table V–2.

VPC now serves most of the utility load in Vietnam. The central coastal area is still served by SIPEA, the last remaining French company.

Demand for electric power in Vietnam is much greater than the supply. As a result, there exists an immediate unsatisfied or pent-up demand. In addition, many customers are receiving poor service, including low voltage, as a result of system inadequacies and interruptions in service due to load shedding and area blackouts.

Saigon Metropolitan Area

The Saigon metropolitan area system peak load for 1970 was 187 MW established August 21. Subsequently, on April 22, 1971, a peak of 199.7 MW was recorded which remains as the year's highest although a top of 215–220 MW is possible as construction of new lines is completed in the latter months according to VPC.

Generation capacity to meet daily load requirements is barely adequate in the Saigon area. The interconnected system is supplied by a mixture of steam, gas turbine, and diesel-driven units totaling 269.1 MW installed capacity; 224.9 MW available.

The largest unit in operation is a 33–MW steam turbine at the Thu Duc station which has been in service with little maintenance since 1966. Other small steam-driven units date from the year 1920 and represent a variety of manufacture. Installation of two new 66–MW steam turbines is progressing well at Thu Duc station with the first expected to be in service in May and the second in August, 1972.

Gas turbine capacity has been augmented this year by installation of two 15–MW units at Thu Duc, increasing the gas turbine capacity to a total of 57 MW.

Diesel-driven units now number 77 in a variety of manufacture ranging in size from 0.5 to 2.9 MW with aggregate available capacity of 129 MW. The diesel units are grouped at 14 different locations. Some of these diesels date back to 1950, and it is reported to be a normal situation for one or more units in each group to be down for maintenance. An additional installation of 96 MW in heavy oil diesel units, now under construction, is expected to be completed in 1972.

Power from the 160–MW Da Nhim hydro station near Dalat, which became available to the Saigon area in 1964, was lost in 1965 when the transmission line was seriously damaged by war activity and the plant penstocks were subsequently ruptured. Restoration of the plant is now in process. The Da Nhim–Saigon 230–kV transmission line, a single-circuit steel tower, 795 M.cmil ACSR facility 257 km in length reportedly has approximately 50 damaged towers

TABLE V-1

VIETNAM POWER COMPANY
INSTALLED AND AVAILABLE GENERATING CAPACITY AT 31 DECEMBER 1970
GROSS AND NET GENERATION – 1970

Station Name	Prime Mover*	Capacity - kW Install	Capacity - kW Avail	Gener Gross	
Saigon Area					
Choquan	S	51 675	35 600	256 268	237 205
Thu Duc	S	33 000	33 000	256 270	243 987
Subtotal	S	84 675	68 600	512 538	481 192
Thu Duc	GT	27 500	27 500	51 532	50 862
Cholon	D	20 995	13 600	67 338	65 231
Cau Kho	D	5 330	1 800	8 205	7 547
Thu Duc	D	21 000	19 750	53 805	53 204
Tan Son Nhut	D	18 500	14 050	34 608	33 762
Thai	D	3 000	1 800	107	106
Khanh Hoi	D	10 500	7 250	22 003	21 778
Vo Tanh	D	6 300	5 500	18 379	18 174
Chanh Hung	D	10 500	9 250	30 949	30 599
Dong Nai	D	10 500	8 700	28 964	28 637
Phu Tho	D	10 500	9 250	36 459	36 065
Xa Lo	D	21 000	21 000	71 081	70 284
Chi Hoa	D	10 500	10 500	40 672	40 219
Hoa An	D	6 300	6 300	9 643	9 529
Subtotal	D	154 925	128 750	422 215	415 135
Total Saigon		267 100	224 850	986 284	947 190
Provinces				Generation kWh	
Central Region				Gross	Net
Bao Loc	D	660	390	924 299	892 128
Cam Ranh	D	800	760	1 068 842	1 061 361
DarLac	D	1 300	880	1 606 816	1 577 132**
Dalat/Ankroet	D	2 840	2 120	2 734 750	2 653 774**
Kontum	D	1 070	570	1 583 980	1 567 195
Phu Bon	D	450	310	275 224	264 829
Pleiku	D	2 010	1 013	4 359 450	4 351 156
Qui Nhon	D	10 708	5 400	12 654 000	12 351 054
Quang Ngai	D	1 430	825	2 502 681	2 470 285
Quang Tin	D	900	540	1 238 935	1 233 849
Tuy Hoa	D	1 852	1 270	2 084 250	2 064 111
Subtotal	D	24 020	14 078	31 053 227	30 486 874
DarLac	H	760***	560	3 064 046	3 007 438**
Dalat/Ankroet	H	3 100#	1 920	12 421 300	12 053 506**
Subtotal	H	3 860	2 480	15 485 346	15 060 944**
Total		27 880	16 558	46 538 573	45 547 818

TABLE V-1

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TABLE V-1-CONT

VIETNAM POWER COMPANY
INSTALLED AND AVAILABLE GENERATING CAPACITY AT 31 DECEMBER 1970
GROSS AND NET GENERATION – 1970

Station Name	Prime Mover*	Capacity - kW Install	Capacity - kW Avail	Generation kWh Gross	Generation kWh Net
Provinces Cont					
Eastern Region					
Binh Duong##	D	900	200	–	–
Binh Tuy	D	400	350	217 440	215 266
Go Cong	D	604	555	1 680 154	1 672 504
Kien Hoa	D	1 090	720	2 941 929	2 903 777
My Tho	D	3 463	2 360	8 235 765	8 004 647
Long An	D	1 036	785	2 159 145	2 126 815
Phuoc Le	D	686	610	1 699 522	1 695 855
Phan Thiet	D	1 682	820	3 165 767	3 122 314
Tay Ninh	D	1 300	980	3 019 341	2 965 708
Vung Tau	D	7 050	6 640	12 122 863	12 105 480
Hau Nghia###	D	250	220	–	–
Long Khanh###	D	1 304	–	–	–
Binh Long###	D	496	340	–	–
Kien Tuong###	D	193	–	–	–
Phuoc Long###	D	165	100	–	–
Subtotal	D	20 619	14 680	35 241 926	34 812 366
Western Region					
Bac Lieu	D	675	540	1 152 836	1 140 786
Chau Doc	D	750	585	2 454 410	2 434 388
An Xuyen	D	1 120	950	801 398	799 840
Can Tho	D	8 033	5 530	19 244 730	18 935 740
Chuong Thien	D	510	160	381 081	372 744
Long Xuyen	D	3 652	3 290	7 300 850	7 271 780
Soc Trang	D	1 626	1 325	4 492 820	4 453 892
Sa Dec	D	1 040	830	3 151 633	3 101 873
Tra Vinh	D	1 008	735	2 467 930	2 445 500
Vinh Long	D	1 976	1 360	6 309 132	6 277 436
Rach Gia	D	2 292	1 170	620 950	611 435
Kien Phong###	D	375	290	–	–
Subtotal	D	23 057	16 765	48 377 770	47 845 414
Da Nhim	H	160 000	–	–	–
Total		183 057	16 765	48 377 770	47 845 414

*D=Diesel, GT=Gas Turbine, H=Hydro, S=Steam
**Estimated between hydro and diesel on basis of gross production
***Ankroet Station

Drayling 480 kW, La Nao 280 kW
Power supplied from Thu Duc
Installation completed at end of 1970

TABLE V-1-cont

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TABLE V - 2

VIETNAM POWER COMPANY
INSTALLED AND AVAILABLE GENERATING CAPACITY AT 31 DECEMBER 1970
GROSS AND NET GENERATION – 1970
NET SYSTEM INPUT – 1970

Summary by Prime Mover and Region*

Prime Mover	Capacity - kW Install	Capacity - kW Avail	Generation - MWh Gross	Generation - MWh Net
Steam	84 675	68 600	512 538	481 192
Gas Turbine	27 500	27 500	51 532	50 862
Diesel	222 621	174 273	536 887	528 280
Hydro	163 860	2 480	15 485	15 061
Total	498 656	272 853	1 116 443	1 075 395
Purchased	–	–	–	818
Total	498 656	272 853	1 116 443	1 076 213

Region	Capacity - kW Install	Capacity - kW Avail	Gen & Purch - MWh Gross	Gen & Purch - MWh Net
Saigon Area				
Generation	267 100	224 850	986 284	947 190
Purchased	–	–	–	818
Total	267 100	224 850	986 284	948 008
Central	27 880	16 558	46 539	45 548
Eastern	20 619	14 680	35 242	34 812
Western	183 057	16 765	48 378	47 845
Total VPC	498 656	272 853	1 116 443	1 076 213

VPC Transmission and Distribution Losses Unaccounted For

	Net System Input MWh	Consumption MWh	T&D Losses Unaccounted For MWh	T&D Losses Unaccounted For Percent
Provinces				
Central	45 548	30 671	14 877	32.7
Eastern	34 812	23 531	11 281	32.4
Western	47 845	35 151	12 694	26.6
Total	128 205	89 353	38 852	30.3
Saigon and Vicinity	948 008	794 967	153 041	16.2
TOTAL	1 076 213	884 320	191 893	17.9

NOTE: There is some uncertainty about net system input in the provinces and about consumption in all areas. For example, the Saigon area supplied service in 1970 to Binh Duong center, where total consumption amounted to 2993 MWh. It is assumed that this consumption, as well as net system input to supply it, has been included in the above statistics for the Saigon area.

**Data obtained from VPC.*

TABLE V-2

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and a substantial amount of the conductors damaged or stolen. Power from this source, however, cannot again be brought to Saigon until hostilities cease or the area between Da Nhim and Saigon is made more secure.

Subtransmission at 66 kV serves eight 15-kV substations from a loop surrounding the more densely populated portion of the city. Capacity of the loop is adequate for the present situation; actually, it is lightly loaded because of diesel installations at several of the substations. The main loop, a single circuit of 795 M.cmil ACSR, is carried on a variety of structures including double and single circuit steel towers and steel poles. Three of the substations presently have radial feed from other substations situated in the loop. The main loop is intersected by a small internal loop or crosstie which supplies one substation. The major loop was designed to permit upgrading to 132 kV should future requirements so dictate. A radial 66-kV circuit is now being constructed from Cholon Substation, on the westerly side of the loop, south to My Tho, approximately 60 km, to provide a more substantial supply to that area. Construction is chiefly on 45-foot wood poles with bayonet using aluminum conductor of approximately 300 M.cmil.

Step-down from 66– to 15–kV distribution is accomplished through 13 transformers with nameplate capacity totaling 272 MVA. On July 10, 1971, a recent peak day of the week, one of the 13 units had a maximum load equivalent to rating; other units were loaded moderately up to approximately 68 percent of nameplate. This apparent overall comfortable position in substation capacity reflects the considerable diesel generation which inputs directly to the distribution lines in these and other substations.

A large portion of the primary distribution system, particularly in the Saigon–Cholon sector, is direct-buried cable, conduit being utilized only for street crossings but without manholes. More recent cable installations have been at 15 kV and there still remains a sizeable portion of the older underground area served at 6.6 kV. Of the approximately 494 km of underground primary, 186 km are operating at 6.6 kV and 308 km at 15 kV. The 6.6 kV is supplied by step-down from the 15 kV and by diesel direct to 6.6–kV buses.

A major supply to the downtown area from the 66-kV loop system is via sixteen 15-kV submarine cables crossing the Kinh Doi Canal and operating in four groups of four each to connect the Chanh Hung and the Cholon 15-kV buses. More recent 15-kV lines have been constructed overhead using concrete, wood, and steel poles to extend service to new areas and to reinforce underground supply in older sections. The length of overhead primary is approximately 230 km.

Both underground and overhead systems are three-phase, three-wire, relying chiefly on the substation breakers for protection and fault isolation. Recent readings indicate that with few exceptions feeders are operating within rating under present load conditions and arrangement of diesels and transport feeders. Maintenance and outages, however, are reported as high on the old 6.6–kV cables. Distribution transformers are essentially all three phase with a total installed capacity in excess of 400 MVA.

On the underground system, transformers, all of which tend to large sizes for a normal distribution system, are housed in "cabines"— small masonry buildings— while those on the overhead system are mounted on wood or concrete pole platforms on H-frame structures. Overload problems exist on some of these units. All secondaries are three-phase, four-wire 120/208 or 220/380 volt, the former predominating. Street secondaries in all cases are carried overhead, chiefly on concrete poles. Long secondary runs, coupled with small conductors both in main line and in the service loops, appear to be the chief culprits in creating widespread low-voltage conditions. This problem is inherent with the system in that high cost of the cabine structure requires that it house a large transformer which in turn must serve long secondary runs to pick up sufficient load to justify the overall investment. The same reasons, to a somewhat lesser degree, mitigate against the use of the platform-type H-frame installations of the overhead system. Much rebuilding and reinforcing, therefore, is necessary even under present load densities to provide transformer and secondary capacity necessary for satisfactory service to many consumers served from the street secondaries. Some larger consumers are served directly from transformers located in the cabines or in vaults provided by these customers or they are served directly at primary voltage. There is no report of dissatisfaction with this arrangement except that some customers must supply partial self-generation.

There are 31 separate street lighting circuits carried along with the street secondaries. These are three-phase circuits metered at the cabine sources for purposes of billing.

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A large industrial component exists which has in excess of 100 MW of on-site generation, a portion of which, we are informed, desires power from VPC. There are other applicants for industrial power as well as various agencies and military installations which desire to be supplied but presently must provide their own generation. All of this has been recognized in the estimated pent-up demand for the Saigon metropolitan area.

Provinces

At the end of 1970, VPC, in addition to the Saigon metropolitan area, was serving 31 province centers and three cities. The sum of the peak loads was 37 MW, the gross generation was 130 159 MWh. The sales were 86 438 MWh, and there were 54 179 meters in service.

Provincial load outside of the Saigon metropolitan area is served primarily by diesel-driven generators at the province centers and by three small hydroelectric stations. These hydroelectric stations are the Drayling, Ankroet, and La Nao stations.

Installed capacity of the diesel stations as tabulated in the 1970 statistical report was 67 696 kW having an availability of 45 523 kW resulting from units out of service for maintenance or lack of parts. The units range in size from 30 kW to 2100 kW. The installed capacity of the hydroelectric plants is 3860 kW with an availability of 2480 kW.

Two primary voltages are used for the distribution of energy, 15 kV and 6.6 kV, with a few of the province centers having both voltages which are gradually being changed to the universal 15-kV four-wire system. At Dalat, the 33-kV line from the Ankroet hydroelectric generating station is a combination distribution and transmission line. In Dalat, the distribution voltage is 3.3 kV.

Secondary voltages are 220/380 and 127/220 with many centers having both voltages. The newer construction is the required 220/380 system and the 127/220 will gradually be eliminated. There are a few cases where there is no primary voltage in the center; the generator voltage is being fed directly to the secondary system. However, this is being changed to the 15-kV primary system with distribution transformers feeding the secondary system as the load increases.

In the older systems, cabines or masonry structures for housing transformers to transform the primary voltage to secondary voltage are used but the newer construction uses pole-mounted transformers. Smaller single-phase transformers for distribution are now being used instead of the larger three-phase type. This permits better voltage regulation of the secondary system and the losses will be lowered as voltage conditions are improved.

The street lighting system is, in general, one where a separate secondary voltage line is carried on the same pole line as the distribution system.

Work has started on the installation of 40 diesel generators in district centers. these locations are shown in Figure V-I. This work is scheduled to be completed in 1971 or early 1972 and will involve diesel generators in size from 60 kW to 900 kW. The total capacity of the 40 units will be 10 762 kW. In addition, a substation will be installed in the Lac Duong district to serve that area in Tuyen Duc province and the Tuy Phuoc area will be served at 15 kV from Qui Nhon center. Approximately 11 450 consumers will be served by the 42 centers.

Several of the province centers, cities, and hamlets were visited by members of the NPS team. These included Dalat, Cam Ranh, Phan Rang, Vung Tau, Phuoc Le, My Tho, and Cho Gao. In addition, the Da Nhim hydroelectric station was visited and the progress of the rehabilitation work was inspected.

In each province visited, the team members were briefed by the electrical province chief on the operation of the system and this was followed by a tour of the local area to provide information on the physical plant. The team members were accompanied on these trips by members of the VPC Saigon headquarters staff and district managers who furnished information on the overall operation and operation of the adjoining systems.

It was found that these local managers have a very good understanding of their systems and are very familiar with the operation of their systems. Each has definite plans for extension of the distribution system and keeps the VPC headquarters informed of these plans. Monthly reports are submitted to the VPC Saigon headquarters and cover the operation of both the generation and distribution systems. These men were very willing to answer questions and to give any information or data that were requested.

In addition to the field visits, considerable information concerning province operations and conditions was provided by eight electrical province chiefs who briefed the team in Saigon. These men were from the following provinces: Phuoc Tuy, Dar Lac, Binh Dinh, Long An, Phong

District Centers to be Served by VPC Expansion Program

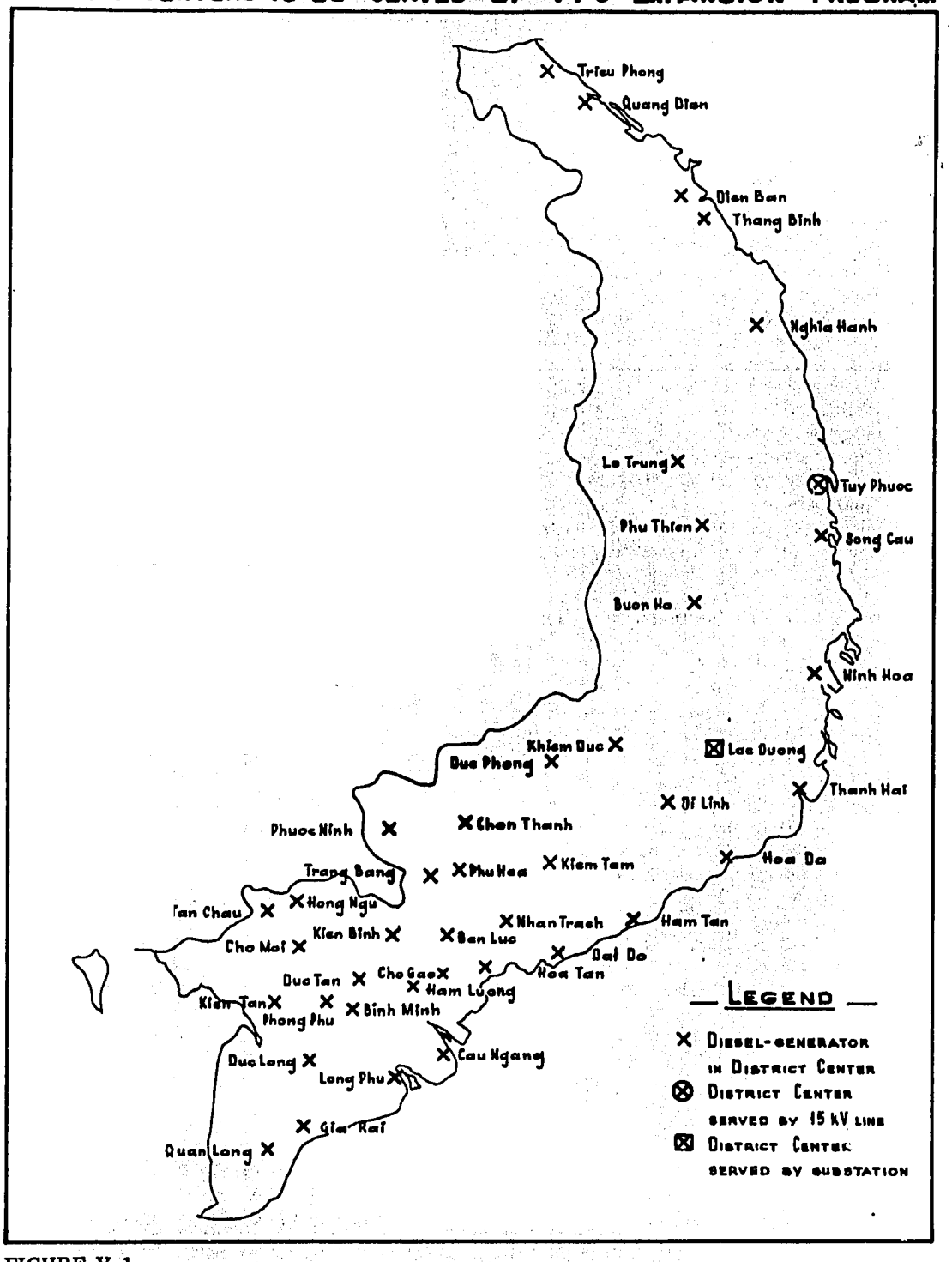

FIGURE V-1

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Dinh, Dinh Tuong, Kontum, and Kien Hoa.

These provinces are representative of the different areas of Vietnam, such as the delta area, the middle highland area, the highland area, and the coastal plain area. In all of the areas, the hamlets have many households that are a combination of residential and small home-owned industrial or commercial operation in the same building.

It was found that the expansion of the distribution systems outside of the province center or city, when adequate power is available, will depend, in part, upon the security of the area. This is especially true in the border provinces and in some parts of the delta area. Parallel with this is the fact that in the less secure areas and the areas that have recently become secure, the income per capita is so low that many of the people cannot afford electrification until they have had an opportunity to restore their land and earning power.

The province chiefs also pointed out that there is a large pent-up demand for service in the centers being served. Several province chiefs cited cases where an additional generating unit was loaded to capacity very quickly after its installation. Each center has a long list of applicants for service and service is given as generating capacity becomes available.

The province area outside of the Saigon metropolitan area is divided into three operating districts: Central, Eastern, and Western. These are shown in Figure V–2.

For many planning purposes, the military regions are used. These four regions are shown in Figure V–3.

SIPEA

The French company, SIPEA, still has franchises in seven areas: Hoi An and Da Nang in Quang Nam Province; Quang Tri and Dong Ha in Quang Tri Province; Hue in Thua Thien Province; Nha Trang in Khanh Hoa Province; and Thap Cham in Ninh Thuan Province. These locations are shown in Figure V–4. The franchises expire in 1975. Each one of these areas has its own generation and each service area is limited to the center or city. As of April, 1971, there were 59 diesel-driven generators in the franchise areas having a total rating of 30 702 kW; seven were out of service and the remaining 52 had an available capacity of 25 745 kW. There were 25 038 meters in service at the end of 1970 with a nondiversified peak demand for the seven service areas of 22 MW. The sum of the gross generation was 97 504 MWh and the sales were 77 326 MWh.

Rural

Central station service to rural areas is very limited. Primarily, it is through three rural electric cooperatives. One is located in the Long Xuyen area of An Giang Province southwest of Saigon, one in the Duc Tu area of Bien Hoa Province north of Saigon, and one in the Dalat area of Tuyen Duc Province. These are shown in Figure V–5. All three of the cooperatives operate distribution systems and purchase all their power needs from VPC. In two of the cooperatives, Long Xuyen and Duc Tu, adequate power is available to meet the needs of the cooperative members. The cooperative in Tuyen Duc has been limited in extending service due to a shortage of power supply. An additional diesel unit has been installed recently at Dalat by VPC which will permit the addition of consumers to lines that have been constructed by the Tuyen Duc cooperative. Some of the lines constructed by the cooperative but not energized have been partially destroyed by sabotage such as poles being cut down or wires broken and removed from several sections with the poles left standing. This damage will have to be repaired before all of the lines can be energized.

The cooperatives were financed by loans from GVN on the basis of a grant made by USAID. An additional loan was made to the Long Xuyen cooperative for the installation of a diesel generating unit to provide power to the cooperative members. This loan was assumed by VPC who installed the unit. VPC has an understanding with the cooperative that any power not needed by the cooperative may be used in Long Xuyen by VPC.

Information on the 1970 operation of the three cooperatives was furnished by the National Union of Electric Cooperatives (NUEC). The Long Xuyen cooperative was serving 12 382 consumers averaging 14.6 kWh/month. The Duc Tu cooperative was serving 9105 consumers averaging 24.2 kWh/month. The higher average is due to many small woodworking plants and other small industries. The Tuyen Duc cooperative was serving 393 consumers averaging 20 kWh/month but expects to add 2000 consumers in the fall of 1971 when the additional generation is made available.

Before any expansion of the existing rural electric cooperatives or the forming of additional cooperatives can take place, additional funds

OPERATING DISTRICTS OF VPC

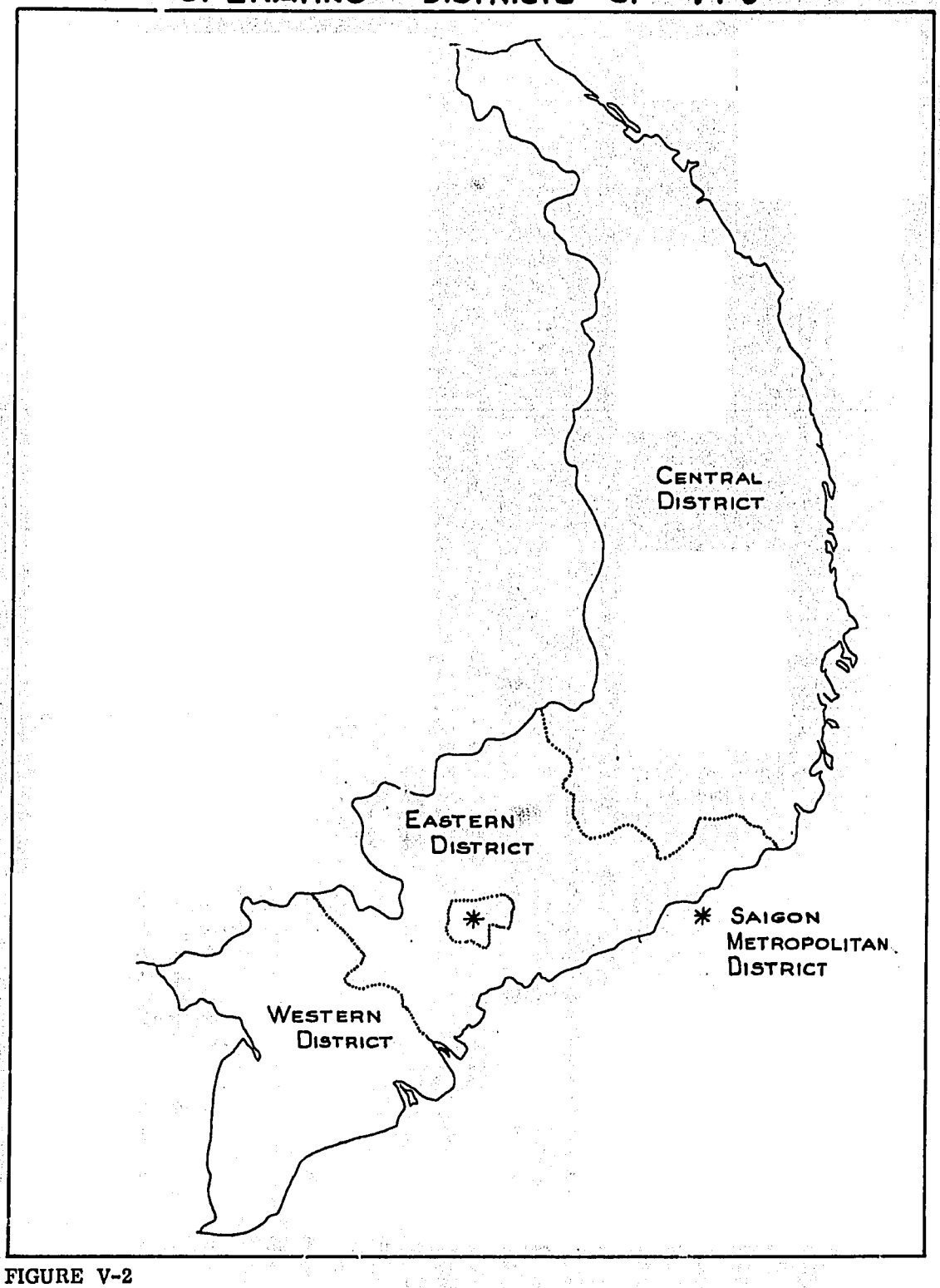

FIGURE V-2

MILITARY REGIONS OF VIETNAM

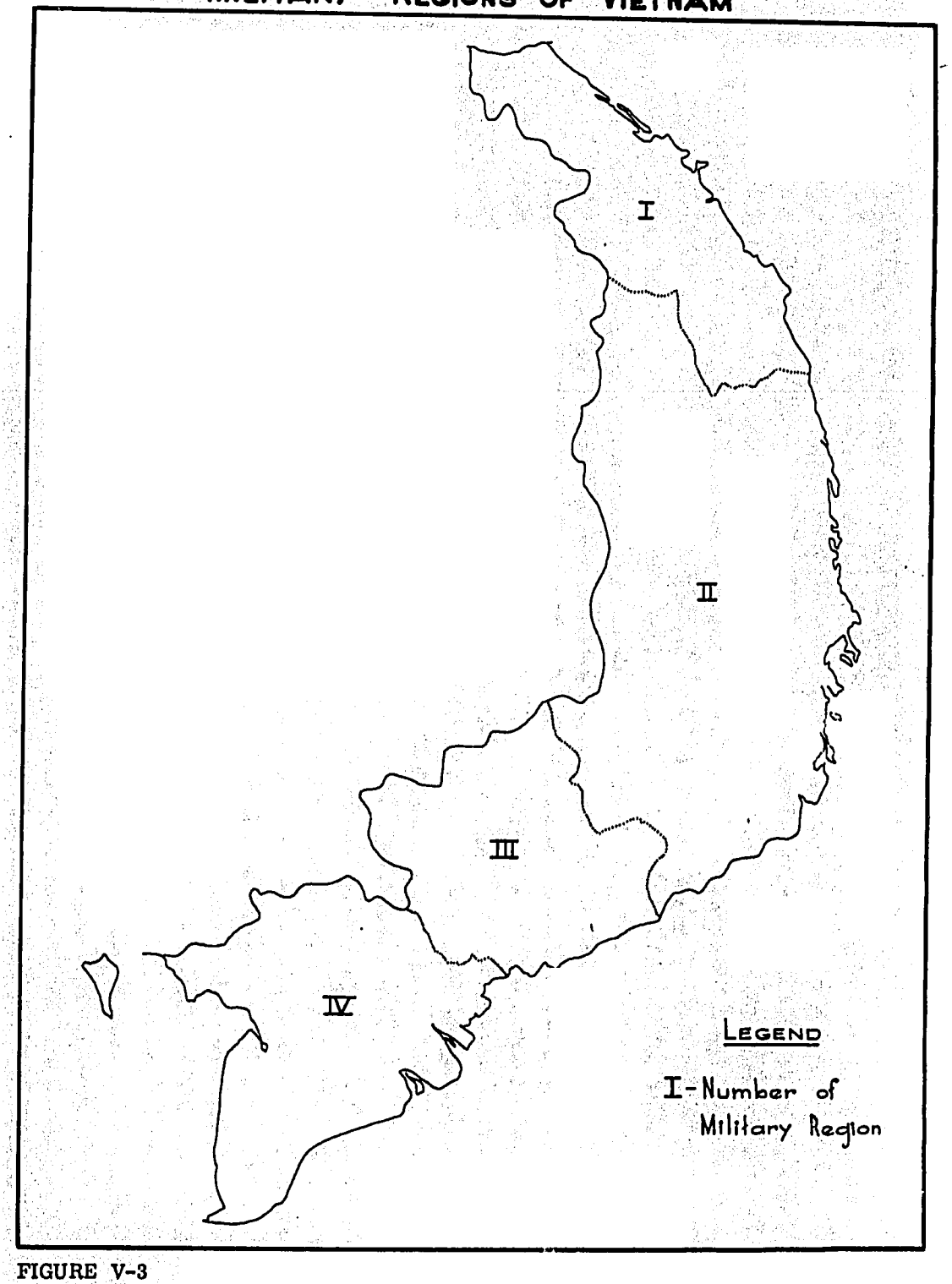

FIGURE V-3

SIPEA Operating Areas

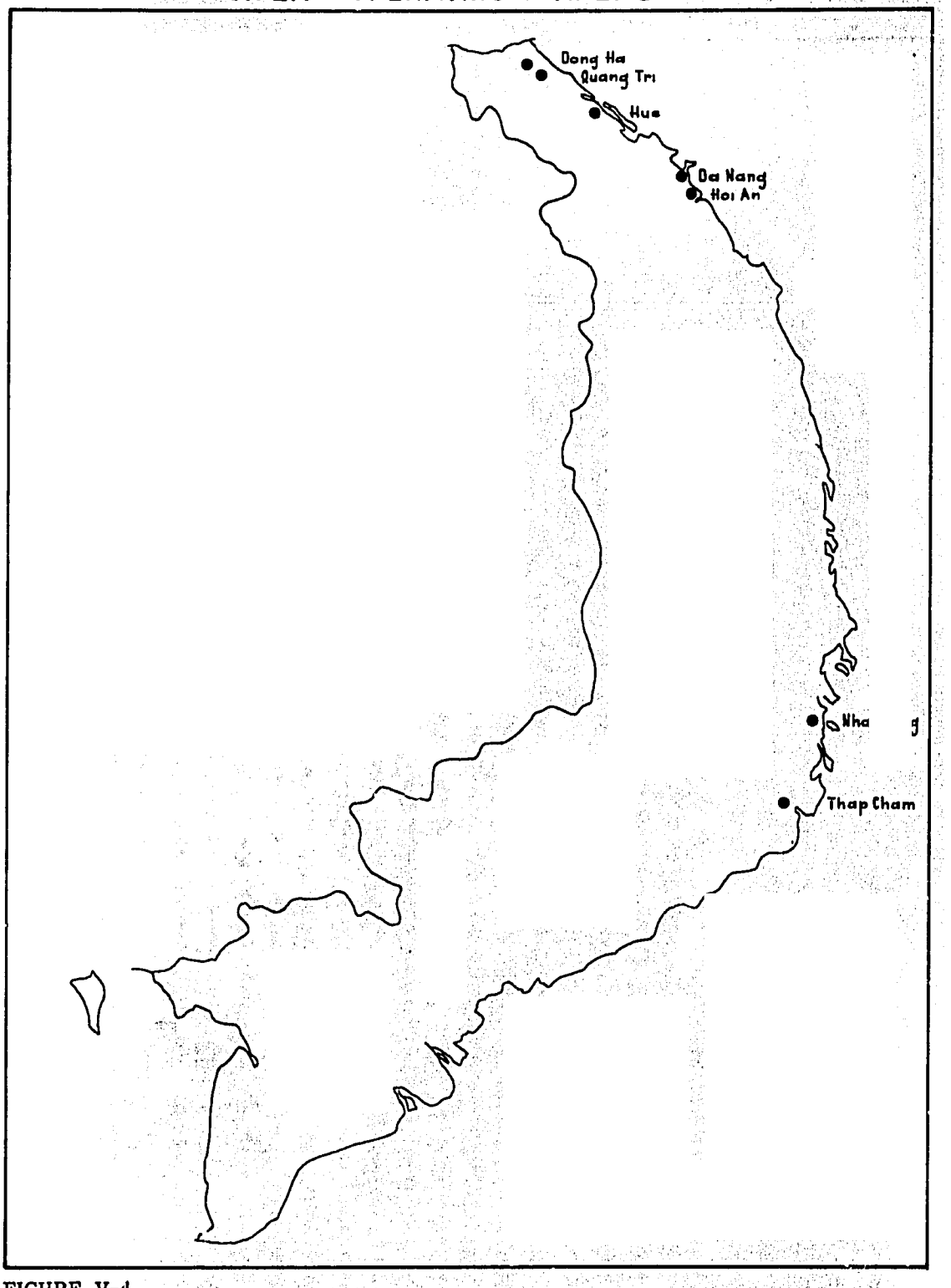

FIGURE V-4

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RURAL ELECTRIC COOPERATIVES

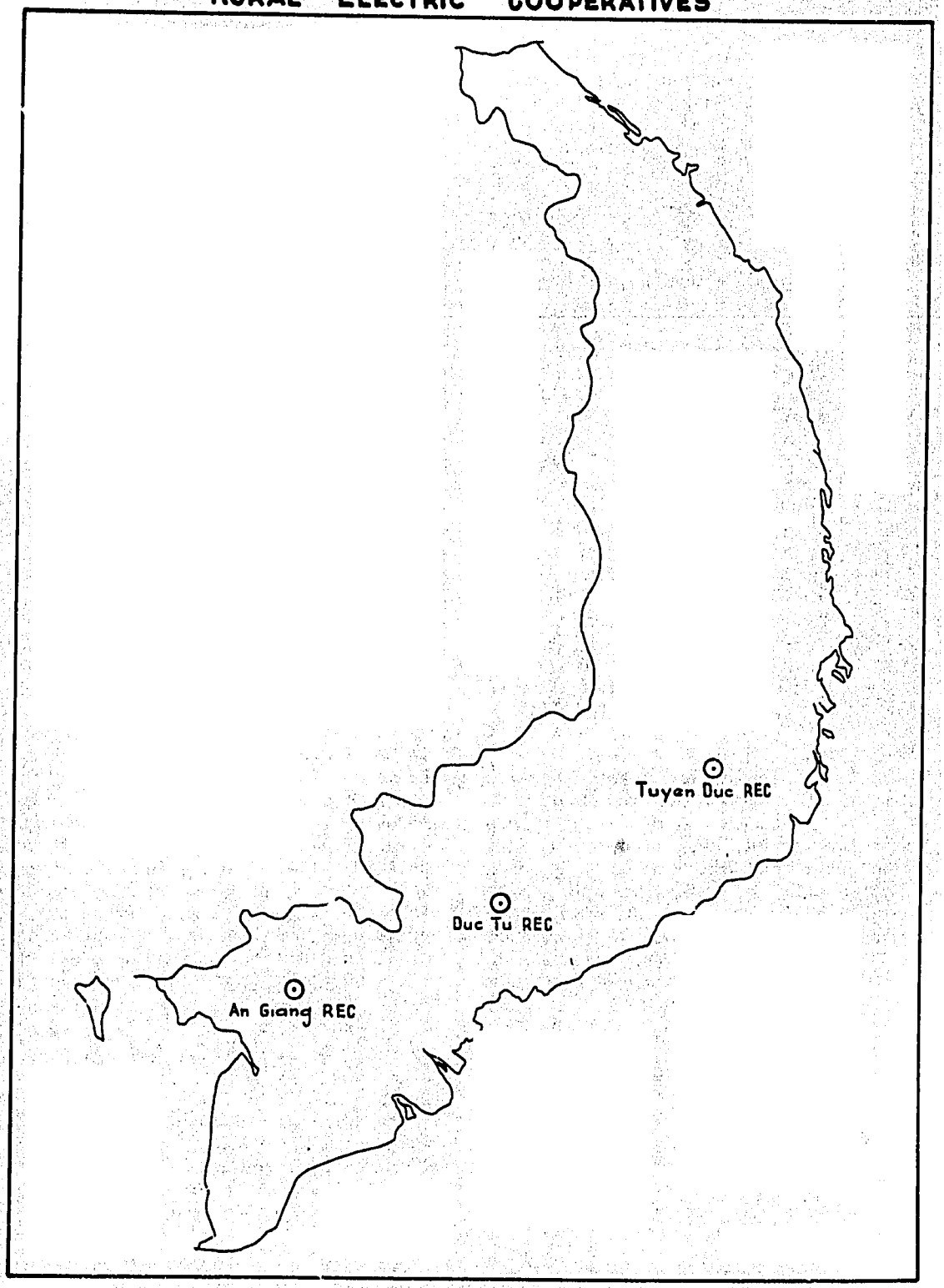

FIGURE V-5

must be made available for loans to the cooperatives. GVN has assumed the responsibility for providing these additional funds under an agreement dated September 14, 1971, between the Director of USAID and the Office of the Prime Minister.

DETERMINATION OF PENT-UP DEMAND

Saigon

Potential demand for the Saigon metropolitan area was calculated on the following basis:

Domestic

The estimated number of households served (250 186) furnished by VPC was accepted as being the best judgment possible. A figure of 367 000 for households which could reasonably be considered as the present potential number to be served was mutually agreed upon, recognizing that within the metropolitan area bounds there are many additional homes too remote from existing lines or which for other reasons would not represent immediate potential but will have to come along later. Using VPC's figure of 1800 kWh per household average annual consumption, the product at 80 percent efficiency, from generation to customer, requires that 825 000 MWh be generated to satisfy this need.[1] Assuming a 50.0 percent load factor, the peak demand for domestic component is 188 MW.

Street Lighting

This demand was assumed to grow along with extension of lines to serve the pent-up domestic load. It was estimated that if domestic pent-up demand were satisfied, the pressure of the public for additional street lighting would be, in effect, a pent-up equivalent to 50 percent of present street lighting. To satisfy this, the street lighting megawatthours were increased this percentage over the year 1970 to a figure of 17.2 GWh, generation. Using a 35 percent load factor, this translated to a demand of 5.6 MW.

Public Building Lighting and Power

No changes were assumed to take place in these components. The 1970 MWh figures of 87.2 GWh and 75.8 GWh, respectively, were supplied by VPC and translated into demand using a 60 percent load factor which resulted in 16.3 MW and 14.3 MW increments, respectively, for the subject items.

[1] 80 percent efficiency used in all calculations by VPC.

Private Industry

This class of load was considered in two parts: First, the present VPC customers including some who have partial on-site generation were assumed to remain as is. The gigawatthours reported by VPC for this portion (260 GWh), assuming a 55 percent load factor, result in a peak of 54 MW. The industry load peak, however, is offset from the system peak and cannot be considered to add directly. System peak loads have been occurring between 1900 hours and 2100 hours. With most industry on single-shift operation, it was considered that only 40 percent of this industrial load peak would coincide with system peak; consequently, 21.3 MW was used for this increment in the system peak load.

A second part of the industrial segment of potential load is that represented by a listing of private generation with a total installed capacity in excess of 106 MW and energy of 211 GWh. It was assumed that after discussion with VPC, 50 percent of this load would convert to VPC sources immediately if adequate service were available. VPC feels ultimately 100 percent of this on-site generation would convert. On a basis similar to that used in this section, assuming a 55 percent load factor, the increment of converted private industrial generation is expected to reflect only 20 percent in system peak and would be 10.7 MW.

USAID—US Information Service (USIS)—US Embassy

Installed generation capacity operated by these agencies is 10 MW as listed by USAID with estimated energy use of 15.8 GWh It was indicated by USAID that this, for the most part, would be VPC potential, again assuming adequate service available. A portion of this, 2 MW, is emergency generation presumed to remain in any case. The remainder converted to demand on the basis of 60 percent load factor, is equivalent to 5.5 MW.

Private Buildings and Multiple Dwellings

An estimate of this category having on-site generation which could be expected to convert to VPC, if power were available, places the increment of demand at 17.6 MW or 22.2 MW at generation with 125 GWh energy use. A load factor of 65 percent was used. Demand was estimated by VPC as reported in the ten-year plan.

Military

An estimate of military installation load

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remaining after the Vietnam Army (ARVN) takeover was supplied by the Military Assistance Command Region V (MACV). It was indicated that VPC would have the business assuming ability to serve. The demand of 16 MW with 83 GWh energy use was used as supplied and 60 percent load factor applied.

The result of building the potential load in blocks as above is a system peak of 300 MW as indicated in Table V–3. Relating this to the 1970 peak of 187 MW, the year upon which all firm data is based, the present pent-up demand in the Saigon metropolitan area is approximately 115 MW.

Province Centers

To determine the pent-up load for province centers, it was assumed that 85 percent of the unserved households would take service, the other 15 percent being financially unable to take service or being located so it was difficult to serve them. The number of unserved households, 299 214, was obtained by subtracting the households receiving service, as shown in the May 1971 VPC report, from the total households by dividing the population by six persons (VPC estimate) per household.[2]

An average of 980 kWh per household per year including 20 percent line losses was used to obtain 248 760 MWh pent-up demand. Applying 47 percent load factor indicates a demand of 59 MW. It was assumed for pent-up load data that existing public lighting, street lighting, etc., would not increase appreciably at the beginning. Increases in these categories will be part of the estimated load growth in future years.

It was assumed that 9 MW of industrial power now being served by units owned by industry

[2] VPC, *Load Forecast for Province Chief Towns in Next Ten Years 1971–1980.* May 1971.

TABLE V–3

POTENTIAL LOAD ESTIMATE – SAIGON METROPOLITAN AREA

Year	Peak MW Actual	Total GWh*	No of Meters	Est No Households Served	Est Pot No Households Served	kWh Households Served	Pot GWh*	Pot MW
1970	187	987.3	143 363	250 186	367 000	1 800	825.0	188.0
			: Street lighting + 50% of present (35% LF)				17.2	5.6
			: Public bldg ltg – present only (60% LF)				87.2	16.3
	1970 immediate		: Public bldg pwr – present only (60% LF)				75.8	14.3
	pent up load =		: Present ind. (Assume 40% only on peak) (55% LF)				260.0	21.3
	300 – 187 =		: 50% of Pvt gen ind (Assume 20% only on peak)(55% LF)				211.0	10.7
	approx 115 MW		: USAID-USIS-Embassy (estimate)				15.8	5.5
			: Pvt bldg and living quarters pvt. gen (VPC est) (65% LF)				125.0	22.2
			: Military (after ARVN takeover) (60% LF)				83.0	16.0
			Total immediate potential load				1 700.0	300.0**
	Losses at 20% of generation							

*Gigawatthour production
** Rounded from 299.9

TABLE V–3

would change to service from VPC. Assuming a 30 percent load factor, the energy component would be 22 500 MWh per year. These figures are based on reports from four provinces where the industry-owned generation amounted to 13 percent of the system load. For this study, 15 percent of peak load was used. This figure may be greater or less depending on the condition of the generating units.

Table V–4 shows the population and households (served and unserved) used in making the calculations for the pent-up load, the estimated megawatt and megawatthour load, and the 1970 actual load.

TABLE V–4

Estimated Load, Including Pent Up, at End of 1970 For Provinces Outside of the Saigon Metropolitan Area

	MW	MWh
Actual demand	59	230 217
Pent-up demand – Province centers and large towns now	59	248 760
Pent-up demand – Outside of Province centers (Group 2)	29	116 000
Industrial now having self-generation	9	22 500
TOTAL	156	617 577

Population	14 218 000
Total Households	2 369 667
Households Served	93 956
Potential Households (Province centers)	254 332
Potential Households (Outside Province centers)	293 000

Rural

To determine the pent-up load for the rural area (the area outside of the province centers and cities), it was assumed that 15 percent of the unserved households would be considered for the pent-up demand. The unserved households were obtained by dividing the population by six persons (VPC estimate) per household. The population figures for the area outside of the province centers and cities were obtained from the 1970 yearbook. The unserved households amounted to 1 951 000.

An average of 300 kWh per household per year plus ten percent for use other than household and 15 percent line loss or 390 kWh at the generator was used to obtain 114 000 MWh of pent-up load. At 45 percent load factor, a peak pent-up demand of 29 MW is indicated.

FUTURE LOAD GROWTH

Load Forecast Method

The history of the electric power industry in Vietnam is not unique for a developing nation under wartime conditions. Like Korea, during a similar period in that country, the wartime economy has produced a demand for electric power service that is far from being satisfied. Consequently, in addition to what may be called a normal load growth, there has been a growing pent-up or unsupplied demand for electric service. Using the figure as the starting point for the estimate of future load growth over the 15-year period makes it possible to consider load projections without the distortions due to pent-up demand. Furthermore, it assists management to make a determination of the rate at which it feels it may be feasible to overtake the pent-up demand.

There is not sufficiently satisfactory information to develop a load forecast by extrapolation.There could also be considerable error in such a projection because of the large annual percentage change in load that normally occurs in a developing country working from a small base load.

Therefore, a load forecast method was used which relates electric power production to the past and expected growth of the national economy using GNP expressed in terms of a constant currency value. This method was used in Thailand.[3] It was compared with actual load growth in the Pa Mong report which found that it produced a reasonably accurate load estimate over the period and was slightly conservative.[4]

Information relating to GNP from 1960 through 1970 and population figures for the same period were provided by the 1970 yearbook. VPC provided historical load data, power consumption by classes, and other basic data.[5]

[3]Electric Power Study Team, *Thailand Electric Power Study*, December 1966. Prepared for the Royal Government of Thailand under USAID contract.

[4]US Department of the Interior, Bureau of Reclamation, *Pa Mong Stage One Feasibility Report.* Prepared for the Mekong Committee and USAID. 1970.

[5]VPC, *Ten Year Forward Look.* October 1970. All references to a VPC ten-year report are from this report.

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The future population growth for the period was taken at 2.6 percent per annum, as discussed in Section II.

In comparing the relationship between per capita income expressed as piastres of GNP to per capita kilowatthour consumption, it was found that there was a correlation for the years 1960 through 1965; however, from 1966 through 1970, due to the increase in war activity and the Tet offenses by the North Vietnamese and Viet Cong in 1968 and 1969, there is a wide dispersal of coordinate points because of the abnormal situation.

For the period 1960–1965, it appears that for each change of one percent in the yearly level of per capita GNP there is an associated change of two percent in per capita kilowatthour generation. Although a longer period of time would be necessary to establish this relationship, the data required prior to 1960 were not available. As in the case of much of the historical data available, there is an absolute minimum in this case. Interestingly, as shown later in this section, a meaningful load projection did result when compared to historical load curves for Korea, Taiwan, and Thailand.

Approximately 75 percent of the total Vietnam load (246 MW in 1970) is in the Saigon metropolitan area. The metropolitan area is described as Saigon, Cholon, Bien Hoa, and environs which are electrically interconnected and within a radius of approximately 30 km from Saigon. The remaining 25 percent serves the province loads and is supplied from approximately 40 isolated systems with generation provided primarily from small diesel plants.

The present pent-up demand and the forecast of growth for the Saigon metropolitan area and provinces were determined separately. The pent-up or unsupplied load that exists today is estimated to be 115 MW for the Saigon metropolitan area and 97 MW for the provinces. The method used to determine the pent-up demand is discussed under a preceding part of this section.

Information provided by the USAID Economics Department and the National Institute of Statistics indicates that the Saigon metropolitan area now produces approximately 28 percent of the GNP. The portion of the GNP produced in Saigon increased from 25 percent in 1960 and it is expected to continue this trend. On this basis, it was assumed that the portion of GNP produced in Saigon would progressively increase from 28 percent to 34 percent for the 1971–1986 period. The population growth rate used for Saigon during this period was four percent per annum which is the same growth rate used by VPC. These data provided a basis for determining the per capita income of GNP separately for Saigon and for the provinces. Rate of growth coefficients were found to be two percent for Saigon and eight percent for the provinces. They were determined by analyzing the past load growth rates and the past estimated per capita incomes for Saigon and for the provinces. To test the validity of the coefficients, a plot was made showing a load projection using the historic coefficient for the total Vietnam load and comparing the convergence of that curve with the sum of the curves developed for Saigon and the provinces. The coefficient derived for Saigon resulted in being the same value as the coefficient determined from the historic total load. This is explained by the fact that Saigon, at present, has over 75 percent of the total load and in the past, it had an even larger percentage.

Therefore, it is reasonable to expect that the past rate of growth for Saigon would also represent the past rate of growth for the nation as a whole. In the future, however, the provinces will have a larger rate of growth since they are expanding from a smaller base load than Saigon. Analyses of the actual growth rates for the past three or four years show that the provinces are growing at a rate faster than Saigon.

Table V–5 and Figure V–6 show the results of this method of load forecasting. The forecast was made from a megawatt value in 1970 that represented the sum of the actual load supplied and the estimated pent-up demand. This shows that in 1970 there was a total potential load of 456 MW as against 246 MW actually supplied. The total Vietnam noncoincident peak load is estimated to be 3000 MW in 1986 if an eight percent annual GNP rate is realized or 2680 MW with a seven percent GNP or 2020 MW at five percent GNP. Also shown on the chart is VPC's load forecast taken from the VPC five year forecast and which has been adopted by VPC as a program. This program indicates that for a seven percent annual GNP growth, the pent-up demand plus load growth would be satisfied about 1976.

After completing the curves, comparisons were made with the actual load growths experienced by Korea, Taiwan, and Thailand. All of them are developing nations which started at relatively low economic levels. Assuming that Vietnam will also have a similar type of growth, the comparisons

TABLE V-5

ACTUAL LOAD, PENT-UP LOAD, LOAD FORECAST, GROSS NATIONAL PRODUCT, AND POPULATION

(FOUR DIGIT NUMBERS ROUNDED TO NEAREST TEN)

TOTAL VIETNAM

		Population		GNP (1960 Prices) Total		GNP (1960 Prices) Per Capita		Gross Generation Per Capita		Gross Generation Total			Noncoin Peak – MW			
	Year	M	% Previous Year	VN$ M	% Previous Year	VN$	% Previous Year	kWh	% Previous Year	kWh M	% Previous Year	Ann LF	Saign	Prov	Total	% Previous Year
Actual	1960	14 100	–	81 928	–	5 800	–	21	–	293	–	–	54	14	68	–
	1	14 500	103	81 684	100	5 630	97	22	105	329	110	49.4	60	16	76	112
	2	14 300	98	89 326	109	6 250	109	25	114	361	110	50.2	65	17	82	108
	3	14 100	99	89 990	101	6 380	102	29	116	410	113	52.5	70	19	89	109
	4	14 400	102	99 064	110	6 880	108	32	110	464	113	55.2	76	20	96	108
	5	15 000	104	107 966	109	7 200	105	34	106	520	112	56.5	81	25	106	110
	6	15 100	100	108 487	100	7 150	99	43	126	651	125	57.2	103	27	130	121
	7	16 300	108	110 673	102	6 770	95	47	109	766	117	60.1	115	30	145	111
	8	16 300	100	105 083	95	6 440	95	50	106	808	105	52.3	137	39	176	121
	9	16 500	101	114 138	109	6 900	107	63	126	1 043	129	55.3	167	48	215	122
	1970	17 300	105	119 500	105	6 900	100	70	111	1 215	116	56.0	187	59	246	114
8% GNP	1970	17 300	–	119 000	–	6 900	–		(1970 actual plus pent up)				300	156	456	–
	2	18 400	102.6	135 000	107	7 340	103						385	209	594	115
	4	19 400	102.6	158 000	108	8 140	105						496	279	775	115
	6	20 400	102.6	183 000	108	8 980	105						629	360	989	114
	8	21 500	102.6	214 000	108	9 950	105						808	460	1 270	114
	1980	22 600	102.6	250 000	108	11 000	105						1 020	580	1 600	113
	2	23 800	102.6	291 000	108	12 200	105						1 260	723	1 980	112
	4	25 100	102.6	339 000	108	13 000	105						1 540	903	2 440	112
	6	26 500	102.6	395 000	108	14 900	105						1 880	1 120	3 000	111
7% GNP	1970	17 300	–	119 000	–	6 900	–		(1970 actual plus pent up)				300	156	456	–
	2	18 400	102.6	135 000	107	7 340	103						385	209	594	115
	4	19 400	102.6	154 000	107	7 940	104						485	272	757	114
	6	20 400	102.6	176 000	107	8 650	104						609	348	957	113
	8	21 500	102.6	200 000	107	9 380	104						765	435	1 200	113
	1980	22 600	102.6	231 000	107	10 200	104						957	539	1 500	112
	2	23 800	102.6	265 000	107	11 000	104						1 180	656	1 840	111
	4	25 100	102.6	303 000	107	12 100	104						1 420	808	2 230	110
	6	26 500	102.6	347 000	107	13 100	104						1 700	985	2 680	110
5% GNP	1970	17 300	–	119 000	–	6 900	–		(1970 actual plus pent up)				300	156	456	–
	2	18 400	102.6	131 000	105	7 110	102						374	202	576	113
	4	19 400	102.6	145 000	105	7 480	102						456	257	713	112
	6	20 400	102.6	159 000	105	7 800	102						553	313	866	111
	8	21 500	102.6	175 000	105	8 140	102						660	378	1 040	110
	1980	22 600	102.6	193 000	105	8 550	102						797	445	1 240	110
	2	23 800	102.6	212 000	105	8 920	102						946	525	1 470	109
	4	25 100	102.6	234 000	105	9 340	102						1 100	624	1 720	108
	6	26 500	102.6	257 000	105	9 780	102						1 280	745	2 020	108

TABLE V-5-CONT

ACTUAL LOAD, PENT-UP LOAD, LOAD FORECAST, GROSS NATIONAL PRODUCT, AND POPULATION
(FOUR DIGIT NUMBERS ROUNDED TO NEAREST TEN)

SAIGON METROPOLITAN AREA

		Population		GNP (1960 Prices) Total			GNP (1960 Prices) Per Capita		Gross Generation Per Capita		Gross Generation Total				
	Year	M	% Previous Year	% GNP	VN$ M̄	% Previous Year	VN$	% Previous Year	kWh	% Previous Year	kWh M̄	% Previous Year	Ann LF	Peak MW	% Previous Year
8% GNP	1970	3 320	—	28	33 300	—	10 000	—	513	—	1 700	—	64	300	—
	2	3 580	104	29	39 200	108	10 900	104	602	109	2 160	114	64	385	114
	4	3 870	104	30	47 400	110	12 300	105	725	110	2 800	114	64	496	114
	6	4 180	104	31	56 700	110	13 600	105	859	109	3 580	114	64	629	113
	8	4 520	104	32	68 500	110	15 100	105	1 020	109	4 600	113	65	808	113
	1980	4 880	104	33	82 500	110	17 000	105	1 200	108	5 820	113	65	1 020	113
	2	5 280	104	34	96 000	109	18 200	104	1 370	107	7 230	112	65	1 260	112
	4	5 720	104	34	112 000	108	19 600	104	1 550	107	8 890	112	65	1 540	111
	6	6 190	104	34	130 000	108	21 000	104	1 750	107	10 800	111	66	1 880	111
7% GNP	1970	3 320	—	28	33 300	—	10 000	—	513	—	1 700	—	64	300	—
	2	3 580	104	29	39 200	108	10 900	104	602	109	2 160	114	64	385	114
	4	3 870	104	30	46 200	109	11 900	105	705	108	2 720	113	64	485	113
	6	4 180	104	31	54 500	109	13 000	105	822	108	3 440	113	64	609	113
	8	4 520	104	32	64 600	109	14 300	105	962	108	4 350	113	65	765	113
	1980	4 880	104	33	76 300	109	15 600	105	1 120	108	5 450	113	65	957	113
	2	5 280	104	34	90 000	109	17 100	105	1 280	107	6 780	112	65	1 180	112
	4	5 720	104	34	103 000	108	18 000	103	1 430	106	8 180	110	65	1 420	110
	6	6 190	104	34	118 000	107	19 100	103	1 590	106	9 840	110	66	1 700	110
5% GNP	1970	3 320	—	28	33 300	—	10 000	—	513	—	1 700	—	64	300	—
	2	3 580	104	29	38 000	107	10 600	103	585	107	2 100	112	64	374	112
	4	3 870	104	30	43 500	107	11 200	103	666	107	2 580	111	64	456	111
	6	4 180	104	31	49 300	107	11 800	103	746	106	3 120	110	64	553	110
	8	4 520	104	32	56 000	107	12 400	103	834	106	3 770	110	65	660	110
	1980	4 880	104	33	63 600	107	13 000	103	930	106	4 540	110	65	797	110
	2	5 280	104	34	72 000	107	13 600	103	1 030	105	5 440	109	65	946	109
	4	5 720	104	34	79 500	106	13 900	102	1 100	104	6 310	108	65	1 100	108
	6	6 190	104	34	89 400	106	14 400	102	1 200	104	7 400	108	66	1 280	108

PROVINCES

8% GNP	1970	14 000	—	72	85 600	—	6 120	—	44.0	—	618	—	45	156	—
	2	14 900	102	71	95 800	106	6 440	103	56.4	114	840	118	45	209	117
	4	15 500	102	70	110 000	108	7 130	105	74.0	115	1 150	118	47	279	117
	6	16 200	102	69	126 000	108	7 790	105	92.5	113	1 520	116	48	360	115
	8	17 000	102	68	145 000	108	8 560	105	116.0	113	1 970	115	49	460	114
	1980	17 700	102	67	167 000	108	9 450	105	144.0	112	2 540	115	50	580	113
	2	18 500	102	66	192 000	108	10 400	105	174.0	111	3 220	114	51	723	112
	4	19 400	102	66	224 000	108	11 500	105	212.0	111	4 120	114	52	903	112
	6	20 300	102	66	260 000	108	12 800	105	256.0	111	5 190	114	53	1 120	112
7% GNP	1970	14 000	—	72	85 600	—	6 120	—	44.0	—	618	—	45	156	—
	2	14 900	102	71	95 800	106	6 440	103	56.4	114	840	118	46	209	117
	4	15 500	102	70	108 000	106	6 970	104	72.4	114	1 120	117	47	272	115
	6	16 200	102	69	122 000	107	7 530	104	90.3	113	1 460	116	48	348	114
	8	17 000	102	68	137 000	106	8 100	104	110.0	112	1 870	114	49	435	112
	1980	17 700	102	67	155 000	106	8 760	104	133.0	111	2 360	113	50	539	111
	2	18 500	102	66	175 000	106	9 450	104	159.0	110	2 930	112	51	656	110
	4	19 400	102	66	200 000	106	10 300	105	190.0	110	3 680	112	52	808	110
	6	20 300	102	66	229 000	107	11 300	105	225.0	110	4 570	112	53	985	110
5% GNP	1970	14 000	—	72	85 600	—	6 120	—	44.0	—	618	—	45	156	—
	2	14 900	102	71	93 000	104	6 240	102	55.0	113	815	116	46	202	115
	4	15 500	102	70	102 000	104	6 580	103	68.5	112	1 060	115	47	257	114
	6	16 200	102	69	110 000	104	6 790	102	81.4	110	1 320	112	48	313	111
	8	17 000	102	68	119 000	104	7 040	102	95.6	109	1 620	111	49	378	110
	1980	17 700	102	67	129 000	104	7 280	102	110.0	108	1 950	110	50	445	109
	2	18 500	102	66	140 000	104	7 570	102	127.0	108	2 350	110	51	525	109
	4	19 400	102	66	154 000	105	7 950	102	146.0	108	2 840	110	52	624	109
	6	20 300	102	66	173 000	106	8 500	103	170.0	108	3 450	111	53	745	109

TABLE V-5-cont

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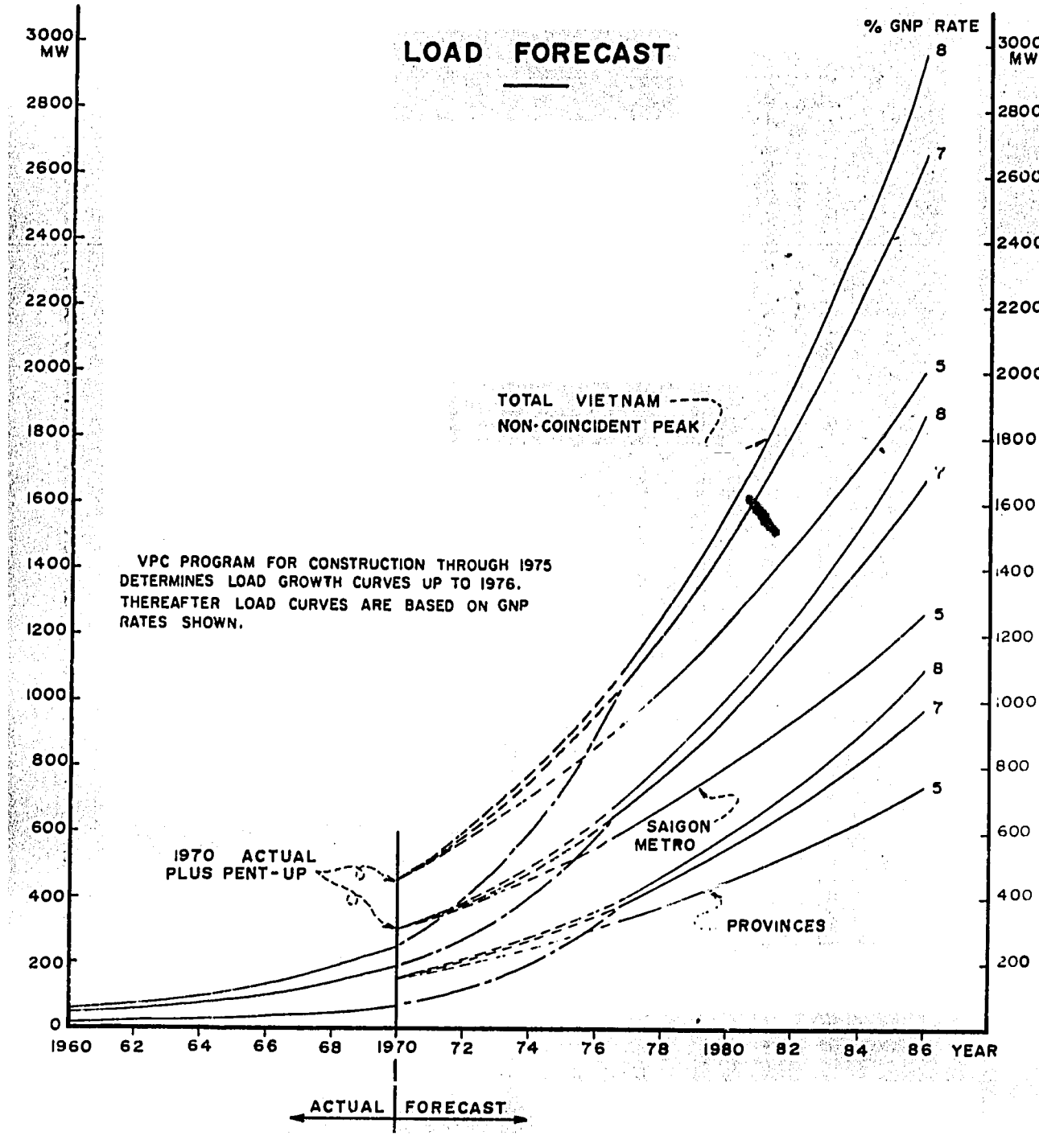
LOAD FORECAST
% GNP RATE
3000 MW
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
8
7
5
8
7
5
8
7
5
TOTAL VIETNAM
NON-COINCIDENT PEAK
VPC PROGRAM FOR CONSTRUCTION THROUGH 1975 DETERMINES LOAD GROWTH CURVES UP TO 1976. THEREAFTER LOAD CURVES ARE BASED ON GNP RATES SHOWN.
1970 ACTUAL PLUS PENT-UP
SAIGON METRO
PROVINCES
1960
62
64
66
68
1970
72
74
76
78
1980
82
84
86
YEAR
ACTUAL
FORECAST

FIGURE V-6

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confirmed that the method used did give an acceptable future load growth projection. The load growth projection based on a seven percent annual growth was reasonably consistent with the load growths of the other countries. The JDG had indicated that a seven percent annual GNP rate of growth was feasible. After discussions with the Minister of Public Works, the President of VPC, and with responsible USAID personnel in Vietnam, it was concluded that a load projection based on a seven percent annual rate of growth of the GNP would be satisfactory for initial planning purposes, subject to a careful review on an annual basis for the succeeding 15 years with revisions as might be found desirable in the light of future developments in the economy, power demands, and related matters. Figure V–7 shows the comparisons of Vietnam calculated load projection curves and historical load curves for Korea, Taiwan, and Thailand.

Load Estimate with Restricted Funds – Case 1

The Scope of Work requested an estimate of "The load that will result with the expenditure of a reasonable total of construction funds." This question, as a practical matter, cannot be determined purely on a dollar basis if the VPC effort is to have any useful participation in the economy of Vietnam.

The JDG said that a minimum growth of only 4.5 percent in the GNP would represent practically a subsistence level with the economy just keeping ahead of the probable growth in population.

It does not seem reasonable to predict what, in effect, is a standstill economy for Vietnam and accordingly, the necessary expenditures over the 15-year period to supply the energy needed for a 5.5 percent growth in the GNP is considered a minimum reasonable expenditure of construction funds. The resulting load curve is shown on Figure V–8.

A plan for system development based on the above rate of growth in the economy has been developed and designated as Plan B. This plan has sufficient generating capacity to provide fully for necessary reserves.

Load Estimate with Ample Funds – Case 2

The Scope of Work also requested an estimate ". . . of the load that will result with the expenditure of ample funds to meet all reasonable needs."

As discussed previously in this section, it was concluded that a load projection based on a seven percent annual growth in the GNP would represent reasonably the power needs of Vietnam over the next 15 years subject to annual review and future revision. This load projection was used to determine a program and the funds required to provide for the necessary production, transmission, and distribution facilities in response to the above request.

A plan of system development based on this load projection has been developed and designated Plan C with sufficient generating capacity to provide for all necessary reserves.

Alternate Plan

In view of the large amounts of capital required, particularly in the early years, it seemed prudent to develop a plan which was based on the load growth used in Plan C but which did not provide fully for reserve generating capacity. Admittedly, this plan would occasionally require some power curtailment in dry water years if a unit had to be taken out of service. However, such dry years are not too frequent, and under average water conditions, the system would have sufficient reserves. Furthermore, and since water records at hydroelectric sites were relatively meager, the dry year energy capability of the hydro plants was reduced by ten percent on the basis that the water records were not long enough to encompass the "driest" year. This plan has been designated as Plan A and is recommended as a minimum plan. As time goes on it would be desirable, if ample funds can be obtained, for VPC to use Plan C. See plans in Section VI.

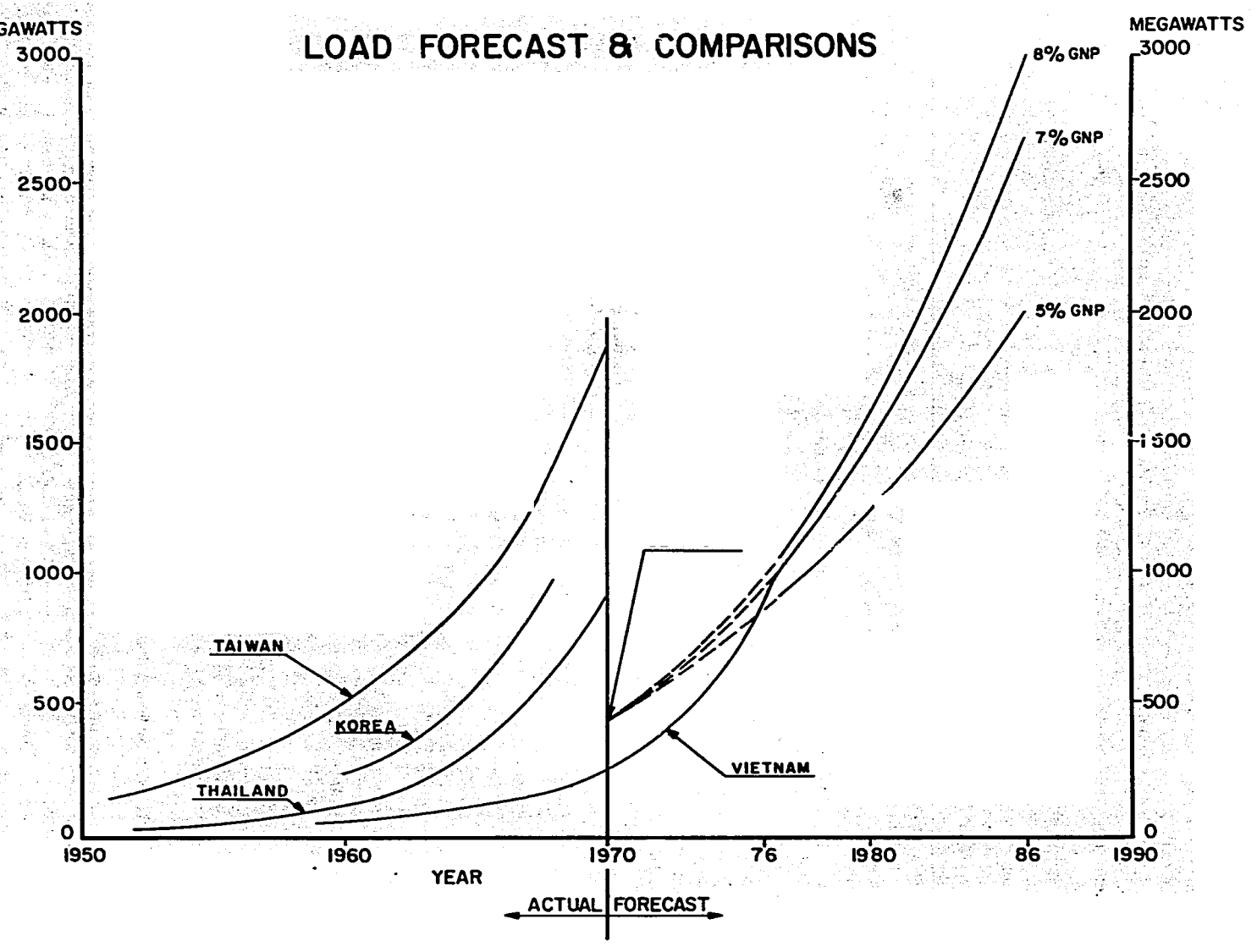
Load Growth After 1986

Historically, it has been demonstrated that developing nations have a very large initial rate of load growth of 20 to 30 percent.

As the load grows larger, the rate of growth declines following a projection known as the Gompertz Curve. This curve asserts that given any growth situation, when the base is small, growth is relatively large and that as the base grows the rate of growth decreases but the increment of growth becomes large since the percentage of growth is taken on a larger base. In the US, existing load has been doubling about each ten years.

In Vietnam, on the basis of seven percent rate of growth in the GNP, it is estimated that the load will grow from the indicated load of 456 MW including pent-up in 1970, to 2680 MW in 1986 or almost sixfold. In the next 15 years after 1986, it may be reasonable to suppose that the load could grow another fourfold or from 2680 MW to nearly 11 000 MW.

FIGURE V-7


LOAD FORECAST & COMPARISONS
MEGAWATTS
3000
2500
2000
1500
1000
500
0
MEGAWATTS
3000
2500
2000
1500
1000
500
0
8% GNP
7% GNP
5% GNP
TAIWAN
KOREA
THAILAND
VIETNAM
1950
1960
1970
76
1980
86
1990
YEAR
ACTUAL
FORECAST

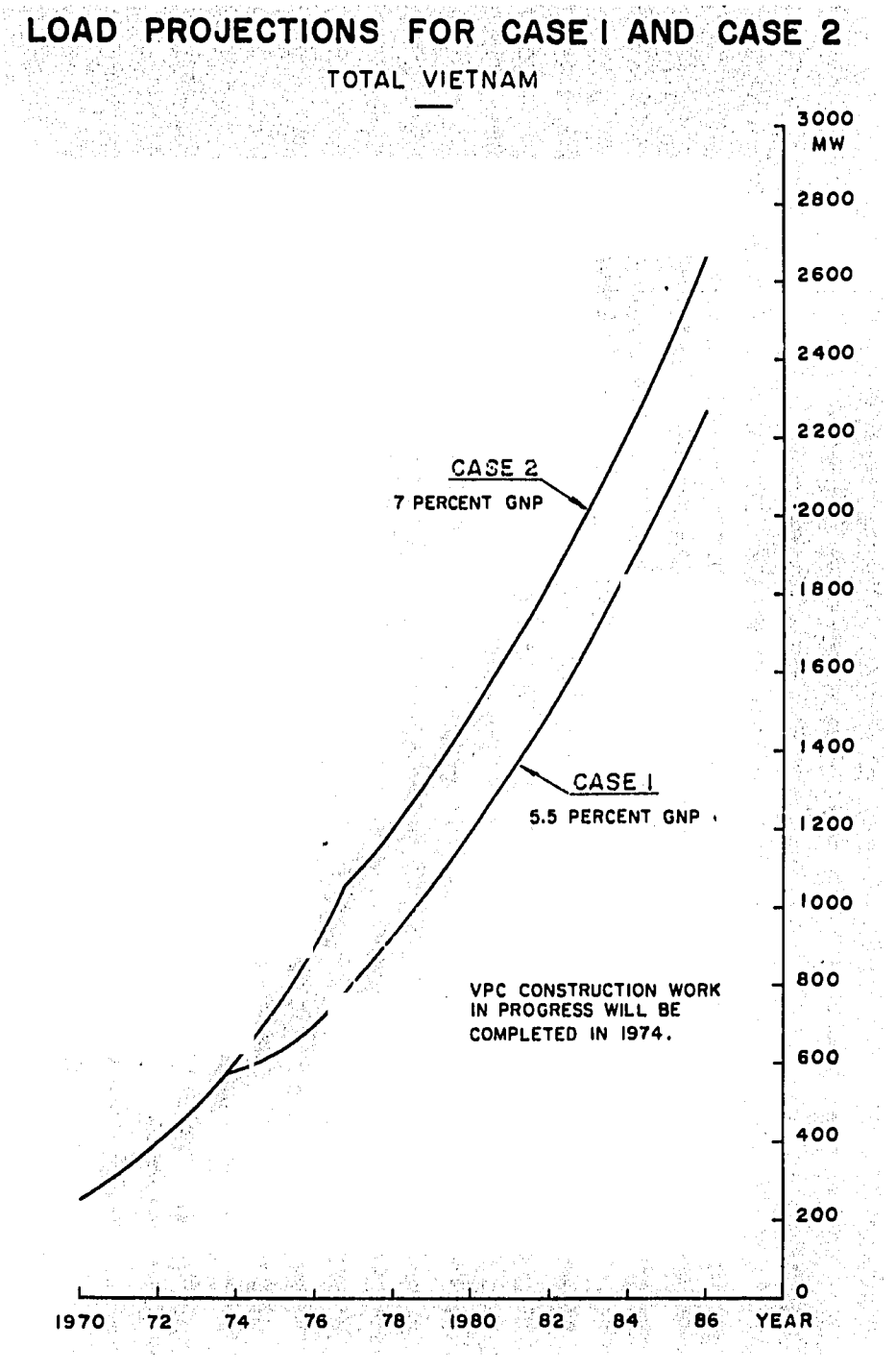

LOAD PROJECTIONS FOR CASE I AND CASE 2
TOTAL VIETNAM
3000 MW
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
CASE 2
7 PERCENT GNP
CASE I
5.5 PERCENT GNP
VPC CONSTRUCTION WORK IN PROGRESS WILL BE COMPLETED IN 1974.
1970
72
74
76
78
1980
82
84
86
YEAR

FIGURE V-8

SECTION VI
SYSTEM DEVELOPMENT

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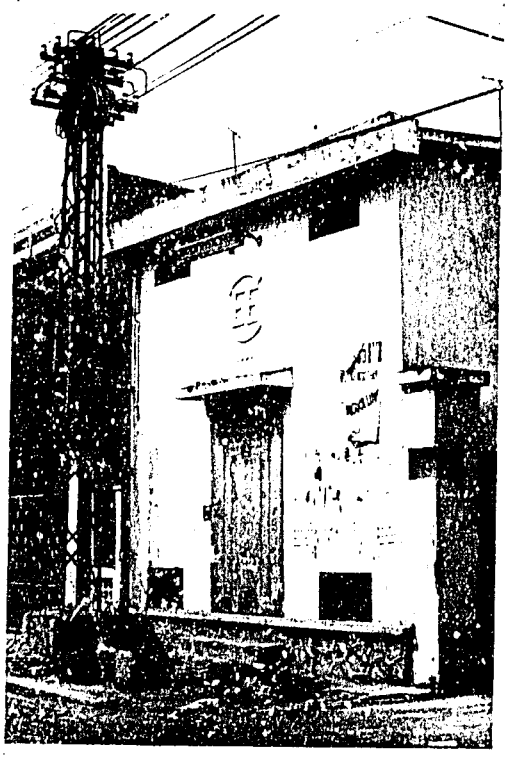

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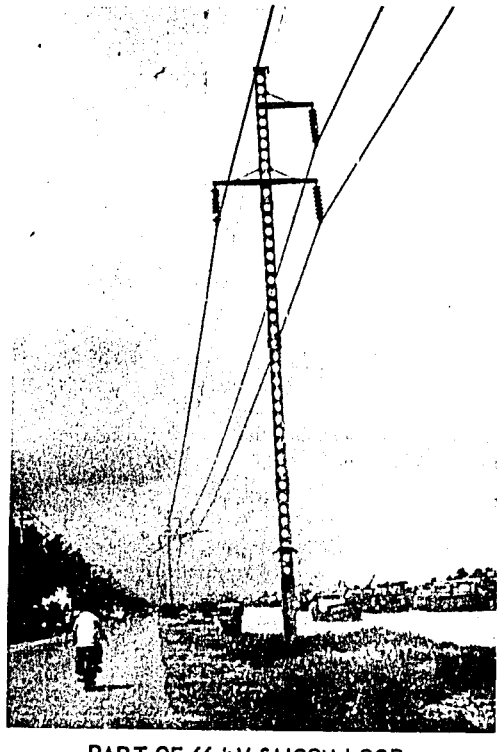

PART OF 66-kV SAIGON LOOP

SECTION VI

SYSTEM DEVELOPMENT

PLAN OF DEVELOPMENT

Recently, VPC developed a five-year power supply program with a view to overcoming the critical power shortage. The shortage was caused primarily by the loss of power from the Da Nhim hydroelectric project in 1965 with the result that generating installations have been, of necessity, on emergency bases. Due to years of neglect by the French companies, the disruption caused by the war, and the flood of refugees, distribution facilities became woefully inadequate. The VPC five-year plan was designed primarily to overcome these difficiencies.

In the development of long-range plans, consultations were had with VPC and adjustments were made in its five-year plan to make it an integral part of the long-range system development plans discussed in this report.

The Scope of Work requested consideration of two plans, and a third plan was considered as a consequence of these two plans as discussed in Section V. These were designated as "B", "C", and "A", respectively. The third plan was designated as Plan A since it is the plan which is recommended for initial planning due to the smaller amounts of capital funds required. It is recommended, however, that as time goes on and if availability of funds permits, that a shift be made to Plan C.

The detailed development of all three plans is discussed in this section.

It is also recommended, as a matter of urgent consideration, that the long-range plan be reviewed each year for the succeeding 15-year period and indicated desirable adjustments made. The plan proposed is not to be considered as a "blueprint" for the future but, rather, as a planning vehicle to be constantly reworked in the light of new data and new developments. This will require a high degree of competence and attention by the system planners.

The potential undeveloped hydroelectric power possibilities in Vietnam are very large. On the other hand, there are practically no domestic fuel resources suitable for use in thermal electric plants. This situation requires that the hydro resources be exploited to the maximum feasible extent.

The potential hydroelectric projects in the Vietnam area are all situated in areas having wet and dry seasons. Furthermore, the catchment areas which supply the water for operating these power plants are quite small in most cases, and the reservoirs can have only limited amounts of storage capacity sufficient for seasonal regulation but not sufficient to provide carryover storage for abnormally protracted dry periods. Needs for irrigation, flood control, etc., must be considered. The result of these limitations is that the power output from these hydro projects may be reduced materially during dry periods. The climate is such that the wet and dry seasons in northern Vietnam are opposite those in southern Vietnam. This diversity in steam flow will be very helpful, particularly as the VPC system expands after 1986 and the northern hydroelectric projects are developed.

In order to insure an adequate power supply to meet the projected demands during abnormally dry periods, sufficient thermal generating capacity has been included in the power development program to supplement the output of the hydro generating stations. It is more economical to utilize thermal generating capacity with its lower capital cost rather than to construct more costly hydroelectric generating stations in order to insure an adequate power supply during the dry periods when the output of the hydro projects is curtailed.

Looking beyond 1986, it may be that eventually a block of firm power could become available to Vietnam from the Sambor hydroelectric project on the lower Mekong River. This project will have a large storage reservoir and it will be integrated with other large upstream projects. Consequently, the Mekong hydro power will not be curtailed by low water in dry periods like the power from the Vietnam hydro projects. An interconnection with the Mekong hydro projects would make it possible for VPC to provide for some of the energy needed during long dry periods and thus reduce the amount of thermal generating capacity required to insure a firm power supply to Vietnam.

The basic criterion used in planning additions to generating capacity was to utilize potential hydroelectric projects to the maximum extent feasible. In addition to the cost of the project, costs for transmitting the output to the load were included. The resulting costs were then compared with the cost of output from an alternate thermal electric plant to determine the most economical selection.

The general system plan of development was to divide the total projected load for Vietnam into regions representing areas that initially could be economically integrated electrically. Initially, the Saigon metropolitan area, the Da Nang–Hue area, the Dalat–Cam Ranh–Phan Rang area, and the delta area surrounding Can Tho were found to be the most feasible. These systems were later interconnected as follows:

First, the restoration of the Da Nhim-Saigon 230-kV line interconnecting the Saigon and Dalat-Cam Ranh and Phan Rang systems. Because of its large relative size, it is referred to as the basic interconnected system.

Next, the Can Tho area is interconnected to the basic system by construction of a 230-kV line from Saigon to Can Tho.

Finally, the Da Nang–Hue area system is connected to the basic system and all the principal areas of Vietnam are interconnected.

In the meantime, isolated areas are brought together and finally integrated into the interconnected system. By 1986, most of the chief province towns and all of the cities will be interconnected electrically.

There are about 400, 60-cycle diesel generating units ranging in size from 500 to 6000 kW which are owned by the US military forces and which operate as isolated systems at military installations. MACV Facilities Engineering office has advised informally that all of these units which are in good condition are expected to be returned to the US.

Load Characteristics

Approximately 75 percent of the total Vietnam load, at the present time, is located in the Saigon metropolitan area and the balance consists of many small isolated loads supplied by local diesel generation. Figure VI–1* shows the shape of the daily load curve of the Saigon area for two similar periods during 1970 and 1971. The peak for the day is shown to occur at 2000 hours, and it usually advances earlier to about 1900 hours during the November–February period when the daylight hours are shorter. Figure VI–2 compares the shape of the Saigon load curve with the province load curve.

The Saigon metropolitan system has experienced a relatively high load factor. Daily load factors of 70 to 75 percent are common while, on the other hand, the provinces have a load factor of only 45 to 50 percent. Interconnecting the provinces with Saigon will produce a load factor in between the two, but the resulting load factor will be nearer to Saigon's since Saigon has the larger part of the total load.

The high daily load factors observed in Saigon are due, at least in part, to a limitation placed on the daily peak because of insufficient generating capacity. There have been occasions during 1971 when the peak load carried for the day was determined by the available generating capacity.

However, in comparing the 1970 and 1971 load curves on Figure VI–1, it can be observed that the energy requirements during the morning and afternoon hours are holding at a higher relative value in 1971 and the dip in the curve is not as pronounced at 1000 hours and 1700 hours in 1971 as in 1970. This effect would tend to increase the load factor for 1971 assuming the peak for the same day was not controlled by a peak generating limitation.

In the load forecast, it was assumed that the load factors would progressively improve. The amount of increase for Saigon was less than that assumed for the provinces and, for the nation as a whole represented by the interconnected system, the annual load factor was increased from 60 percent in 1972 to 65 percent in 1986.

It is of interest to note that for the Israel Electric Corporation, Ltd., the annual load factor increased from 66.7 percent in 1969 to 72.3 percent in 1970 as shown in its annual report. The 1970 peak load for the Taiwan Power Company shown in its 1970 annual report was 70.8 percent. The indicated load factor in the 1970 annual report for the Korea Electric Company was 65 percent. Hence, it is considered reasonable to use an annual load factor for VPC of 65 percent in 1986.

Another significant factor that affects peak demand is diversity. Figure VI–2 indicates that if the province load and the Saigon load were interconnected at the present time, a peak diversity of two percent would be realized. Accordingly, diversity was assumed in the interconnected system load ranging from zero in 1975 to five percent in 1986. The diversity effect in 1986 produces a coincident demand 130 MW less than the noncoincident demand. Interconnecting the Da Nang area in 1985, which is then projected to have approximately 200 MW of load, will further improve the situation.

The development of industry in Vietnam will improve the load factor. This has been demonstrated in Korea, Taiwan, and Israel. Improving load factors, coupled with reductions in peak demands gained with diversity through

*All Figures and Tables will be found at the end of this section.

interconnections, will reflect as an improvement in the system operating economy.

Just as load forecasts must be periodically reviewed and brought up to date, load factors also should be observed because a change in the load factor could affect the timing of installation and the amount of new capacity.

The month-by-month peak demands for each year since 1968 are shown in Figure VI–3. The relatively increasing flatness of the curves from 1968 to 1971 and the different peak period can be attributed to the acute shortage of power. When the power shortage has been eliminated, more pronounced annual peaks may be expected. This will be of assistance in scheduling units for maintenance by providing more off-peak time.

GENERATION

General

As discussed in Section V, three system plans, designated Plan A, Plan B, and Plan C were developed. Plan B is a program in answer to the request for a plan assuming a limited amount of construction funds. Plan C is a program in answer to the request for a plan assuming ample construction funds to meet reasonable needs. Plan A is in between Plan B and Plan C and is suggested as an alternate, depending on the amount of construction funds which can be made available. Plan C has more ample reserves and, therefore, is more desirable.

However, Plan A will support the adopted load projection with the probability that in periods of abnormally low stream flow and the coincidence of heavy load periods, some load curtailment will be experienced. It is considered that the funds required for Plan A should be the minimum amount of funds which should be provided. If more funds can be provided, a shift to Plan C should be made.

It should be kept in mind that the load projection might be exceeded. Such countries as Korea, Taiwan, Thailand, Malaysia, and others are experiencing load increases much larger than had earlier been projected.

In any event, as mentioned in Section V and repeated here for emphasis, none of the plans are to be considered as blueprints and annual reviews should be made and changes made as may be indicated by new information and data.

Plan A

Interconnected System

The interconnected system load in 1986 is estimated to be approximately 2500 MW as shown in Table VI–1. This should not be confused with the total VPC load which is 2 680 MW including the isolated systems.

The major hydroelectric projects which are considered to be economically feasible and which are included in Plan A, are listed in Table VI–2. These projects have had sufficient preliminary investigation and hydrological data to be considered at this time. However, further investigation of most of the projects will be necessary before final selection can be made.

Dry year hydro energy capability conditions were assumed for each hydro project, and the energy margin (capability less load) was allowed to approach zero before a new project was added. Because of the inadequacy of hydrological data, the dry year hydro energy capability was discounted by ten percent as a contingency factor. Similarly, generation was added when the margin for capacity was approaching zero.

Figures VI–4, VI–5, VI–6, VI–7, and VI–8 show annual load duration curves for several representative years and illustrate the hydro and thermal energy under both dry and average year water conditions. They also indicate the large reduction in fuel costs per kilowatthour made possible by construction of the hydroelectric plants.

Principal Vietnam power supply areas are centered around Saigon and Da Nang. Saigon is much the larger of the two and the integrated Saigon area is considered as the beginning of the interconnected system for Vietnam. As other integrated and isolated areas are brought into the interconnected system, the load to be served from the system will show increases as indicated on Figure VI–9. Tables VI–2 and VI–3 show peak and energy capabilities for Plan A.

The sequence of project installation is as follows:

1. Can Tho Thermal Power Plant

In developing the generation plans, power projects currently being considered were reviewed with respect to the long-range program. The Japanese government is finalizing plans to proceed with Stage 1 of the Can Tho thermal power station and subtransmission project. This project is described in a feasibility report and proposes for Stage 1, a 33-MW stream electric plant and certain 66-kV subtransmission lines.[1] Stage 2 proposes a second 33-MW unit and additional subtransmission lines. Construction

[1] West Japan Consultants, Inc., *Can Tho Thermal Power Station and Subtransmission System Report – Feasibility Report.* March 1971.

funds for Stage 1 have been arranged for and construction is scheduled to begin in 1972. A possible alternate for the second 33-MW unit at Can Tho, consisting of 230-kV transmission line from Saigon to Can Tho and the construction of the second 125 MW unit at Can Tho instead of Saigon, is further discussed in this section in connection with the construction of the Saigon-Can Tho 230-kV line.

With respect to Stage 1, it is believed that operation of the transmission lines at 66 kV will be inadequate in a relatively short time and serious consideration should be given during the initial construction to provide insulation and spacing adequate enough to permit the lines to be operated at 138 kV.

2. Da Nhim Restoration

The Da Nhim hydro plant, now being repaired, was assumed to be available for full operation within the interconnected system by late 1973 and is shown as a power resource in January 1974.

3. Saigon 250–MW Thermal Plant

Currently under consideration by VPC is a proposal for two 125–MW steam electric units to be located in the Saigon area based on a feasibility report prepared by Nippon Koei. [2]

Alternate project possibilities were studied particularly as to size of units. Thu Duc will have 66–MW units and this size was investigated for the new plant. A combination of 66–MW units could be tailored more closely to the early load and reserve requirements. However, the opportunity to provide larger units with lower overall operating costs and fuel saving is an important consideration and the larger capacity will be needed within two years of completion.

There is not sufficient time to investigate and construct an alternate hydroelectric project by the time the power will be needed in 1975. Accordingly, it is recommended that a plant having two units of 125 MW be constructed. In order to have the first unit in operation by mid-1975, the project should be committed as early in 1972 as possible.

4. Da Nhim Extension

This project has been determined to have a very favorable benefit–cost ratio and could be developed before any other major hydro because of the preliminary work already completed. The 106 MW of capacity would be very valuable in meeting interconnected system peak demands. The average year energy load factor of 80 percent which would be available would considerably reduce fuel and foreign exchange requirements.

The project could be completed in 1976 which is also the scheduled completion date for the second 125–MW thermal unit in Saigon.

5. Da Quayon Project

The Da Quayon project would have a total ultimate capacity of 640 MW and would operate at approximately 70 percent load factor in an average year. This project has pumped storage provisions while pumping for load is reduced to 543 MW. The plant would be constructed in three stages. Stage 1, rated at 270 MW, is scheduled for completion in mid-1978; Stage 2, also rated at 270 MW, in mid-1979; and the 100 MW No. 2 plant by the end of 1981.

6. Tri An Hydro Project

Together with the Da Quayon 2, Tri An Stage 1 also is required early in 1981 to carry that year's peak and energy load growth. Tri An is rated 120 MW and has an average year load factor of 64 percent.

7. New Thermal 440–MW Project

In 1982, the principal requirement on the system is additional energy. After careful consideration of possible hydroelectric alternates, it was concluded that, on the basis of existing information, the most economical large energy source would be a thermal plant with an initially installed unit of 220 MW to be in operation in 1982. An additional 220–MW unit would be added by the end of 1982. Before making a final decision on the use of this thermal plant, a careful study should be made in the light of additional information from field investigations of potential hydro plants, cost of money, availability of funds, cost of fuel, etc., to determine if an alternate hydro possibility exists.

8. La Nga–Da Rgna Hydroelectric Project

The La Nga and Da Rgna projects are located near Saigon requiring only short transmission lines to the load center. When completely developed, they will have 425 MW of installed capacity. The projects consist of six separate power plants and will require about eight years to construct in an orderly manner. The first stage of this project will have 90 MW installed capacity and is scheduled for completion by the end of

[2] Nippon Koei, *Saigon 250–MW Thermal Plant Feasibility Report.* May 1971.

1984. Succeeding stages would be completed after 1986. Stage 1 will provide peaking capacity until the main transmission system can be extended north to the Song Ba and Yali hydroelectric projects and interconnection is made with the Da Nang area. The remaining capacity at the La Nga portion of the project was scheduled for final completion by 1988.

9. Song Ba and Yali Falls Hydroelectric Project

The remaining major hydroelectric sites included were Song Ba with 150 MW of installed capacity and Yali Falls with 200 MW of installed capacity. Yali Falls is designated as the first phase of the Upper Se San project. These plants, requiring longer transmission distances to load centers than other hydroelectric projects were scheduled when the interconnected system had progressed to a point when reduced transmission distances from the projects could be available. By the end of 1984, when these plants are scheduled for completion, the Da Nang area is scheduled to be connected to the interconnected system. The Da Nang area, at that time, will have approximately 200 MW of load and will require additional generating capacity which can be provided from the interconnected system. Generation planning for the Da Nang area is discussed in this section.

10. 660–MW Thermal Project

Generation for the years 1987 through 1990, although beyond this study period, was tentatively scheduled in order to include the portion of the construction funds required for those projects that would be spent prior to January 1987.

By that time, the load will be increasing about 350 MW a year. Projects commenced before 1986 and scheduled after 1986 are the Upper Se San hydro (500 MW) and the remaining La Nga–Da Rgna hydro project (335 MW) and the 660–MW thermal plant of two 330–MW units. This steam plant should be studied later to see if there is an alternate hydro possibility.

Da Nang Area

Shown on Table VI–1 is the portion of the total Vietnam load designated as the Da Nang area and for which generation capacity was planned initially as a separate project. The Da Nang area includes Hue and the five northerly provinces and will operate as a separate electrical system until it becomes part of the interconnected system in 1985.

1. Diesel Installation Program

In the Saigon metropolitan area, there are 56 GM diesel units in operation, each rated 2.1 MW, providing a total capacity of 117.6 MW. These are combined into groups of three or five units and located at ten different areas where they can supply power into the 15–kV system.

The diesels are portable and completely self-contained with housing, controls, and 15–kV substation. They were brought to Vietnam for the purpose of supplying interim power until the two 66–MW steam electric units are completed at Thu Duc in 1972.

The disposition of the diesels, when no longer required in Saigon, has not been specifically determined other than a general plan to relocate them into the provinces. These are of too large a capacity for many of the provinces. They are also too large physically to be moved into the rural areas and, therefore, can only be effectively utilized at the larger cities and province centers having transportation access to the sea. The most efficient use of this capacity is to progressively relocate them to Da Nang where there exists a large pent-up demand for electric service.

At Da Nang, the diesels would supply base load power until steam electric plants can be constructed. Following the installation of new thermal capacity at Da Nang, the diesels would continue to have an important function of providing peak reserve capacity for the Da Nang area and later for the interconnected system by relocating some of the sets further south.

Throughout this study, the diesels have been considered as available for either base load, peaking capacity operation, or reserve as conditions at the time required and were not scheduled for deactivation until the first 330–MW unit is completed in 1986.

There is considerable flexibility available to VPC in the method and rate of moving the diesels from Saigon. The distribution program provides for their relocation by increasing substation and distribution line capacity where necessary when the local diesel capacity is removed. Until the distribution capacity is increased, it would be possible to remove only one or two units from a group as it is now composed thereby only partially removing the local capacity. The individual units removed from various sites could be combined with a unit having self-starting features and moved to Da Nang as a 10.5-MW capacity plant.

The units remaining at Saigon would be operated infrequently for reserve or peaking capacity. The rate of relocation depends upon reserve requirement in Saigon and load demand in

Da Nang. Some sets could be used initially at other locations such as Cam Ranh or Can Tho until those areas become part of the interconnected system. By 1979, all GM diesel units are scheduled to be in operation at Da Nang. Experience has demonstrated that the dependable capacity of the 56 units rated at 117.6 MW in total is about 100 MW and this figure has been used in the study using ten groups with 5 units per group each rated 10 MW.

2. New 25–MW Steam Engine Plant

VPC has programmed the installation of two 13.5–MW steam electric generators for Da Nang. This equipment was previously purchased for a plant to be located at An Hoa–Nong Son Industrial Complex near Da Nang, but it could not be constructed due to lack of security. The equipment has been in storage several years and will require considerable repair and parts replacements together with a conversion of the boiler to oil firing rather than coal. This project is scheduled to be completed late in 1973 and is considered as a resource for the Da Nang area load in 1974. Although the plant has a rating of 27 MW, its dependable rating is given as 25 MW.

3. Two 66-MW Steam Electric Units for the Da Nang Area

In 1980, the Da Nang area load will peak at approximately 135 MW which will be supplied by 140 MW of installed capacity consisting of 15 MW small unit diesels, 100 MW GM diesels, and the 25–MW steam plant.

The Thu Bon multipurpose project which would have an installed capacity of 80 MW was not included in the plan. It is located near Da Nang and should be considered as part of the area's potential power supply. However, power cannot carry the full burden of the total cost and appropriations for the costs allocated to irrigation, etc., would have to be made. If and when the costs allocated to power will result in economical power, Thu Bon should be considered.

Power from the Song Ba and Yali projects were considered. However, early completion of one of these major projects ahead of the planned interconnected system development would be more expensive than the more economical thermal installation selected for 1980.

In determining the rating for the thermal units, the following factors were considered:

The GM diesels, by 1980, will be approximately 15 years old, operating during this period primarily as base load plants. New capacity should be large enough to relegate the diesels to peaking service and possible deactivation of some units. The plant should also have sufficient capacity to allow removal of part of the diesels to other areas requiring interim generation. The units should be as large as practical to obtain more economic operation.

These considerations lead to the scheduling of two 66–MW units at Da Nang, one for mid-year 1980 and the other one year later. Figure VI–10 shows the generation expansion program for the Da Nang area and Table VI–4 outlines the capacity installation schedules.

Isolated System

The isolated systems are the small isolated systems outside of and not interconnected to Saigon and Da Nang areas. These systems will continue to operate on an isolated basis until line extensions can be completed from the interconnected system. After interconnections are made, the diesel plants would discontinue operations because less costly energy from the larger central stations will become available.

As shown in Table VI–1, the isolated systems load progressively increases from 80 MW in 1971 to a maximum of 119 MW in 1974; thereafter, it averages approximately 70 MW through 1986.

The generation capacity available for this load was 72 MW in 1970 and will increase to about 150 MW in 1972. The additional capacity, now financed and under contract, will be provided by many small diesel generators rated 200 kW, 500 kW, and 1200 kW.

The significant item to note is that there appears to be adequate diesel generation capacity to supply the isolated loads throughout the 15-year period after allowing for deactivation of some units.

It is suggested that a comprehensive study be made to develop a long-range diesel relocation program, in accordance with the system development program described in this report.

Plan B

This plan was developed in response to a requirement of the work to be performed by NPS. This requirement was to make an estimate over a 15-year period of "The load that will result with the expenditure of a reasonable total of construction funds."

Using the same basic generating plants as used in Plan A, with the exception that two 33–MW units are provided at Da Nang instead of two 66–MW units, a new schedule of construction was prepared by moving the timing of installation of the plants back one to three years. Provision for a reserve equal to the largest unit on the system was made and then the load curve which

a1

the system could support was determined. The magnitude of load for the isolated systems was reduced from a pattern established in Plan A to an average of 60 MW after 1975. The Da Nang area interconnection with the main system was delayed one year to 1986.

It is considered that the result is not satisfactory as a basis of planning. Figure VI–11 and VI–12 and Table VI–5 show the generation plan for Plan B.

Table VI–6 shows the total Vietnam load for Plan B. It will be noted that the rate of load growth provided for makes an abrupt change in 1975 from 24 percent to 4 percent. Plants now under construction or committed, such as Can Tho and the restoration of Da Nhim hydro, are not shown as deferred, and the load which can be carried reflects this situation.

Plan C

This plan was developed in response to a requirement of the work to be performed by NPS. This requirement was to make an estimate over a 15-year period of "The load that will result with the expenditure of ample funds to meet all reasonable needs."

Using the same basic load projection and the basic generating plants as used in Plan A, a new schedule of construction was prepared by moving the timing of installation of the plants forward a sufficient amount to provide for a reserve equal to the capability of the largest unit on the system.

No change was made for Da Nang or the isolated systems. Figure VI–10 and VI–13 and Table VI–7 show the generation plan for Plan C.

Thermal Plant Operation

Deactivation of Units

The Choquan steam plant has a nameplate rating of 44 MW, but due to its condition, is considered in this report to have only 20 MW as available capacity. By today's standard, the equipment is obsolete and costly to maintain.

The completion of units 2 and 3 at the Thu Duc plant, together with the new heavy oil diesels, will increase the generating capacity in Saigon by 230 MW in 1972 and make it possible to place the Choquan plant on a cold standby basis.

Alternatively, the older diesel generating equipment could be placed on cold standby in place of Choquan. These units are located at Cholon, Thu Duc, Can Tho, and Tan Son Nhut with a combined capacity of 23 MW.

As discussed previously, the GM diesels were programmed to have a continuing important function and were not scheduled for deactivation until 1986.

Operating Costs

1. Fuel Costs

In calculating the annual fuel costs on a combined hydro-thermal system, the energy generation available from hydro plants under average year water conditions was determined. The difference between hydro energy and energy required for load is the amount to be supplied by thermal plants.

Thermal plant energy generation schedules were developed in the usual manner by considering plant efficiencies to economically allocate the power to the most efficient plant. Tables VI–8 and VI–9 show the plant participation and generation schedules for Plans A and C, respectively. A generation schedule, as such, was not developed for Plan B since its fuel cost determination was derived from total thermal energy requirements as related to Plans A and C. Applying applicable plant heat rates and fuel prices, each plant's energy cost is shown as follows:

Plant	Rating MW	Net Average Heat Rate Btu/kWh	Average cost per kWh-US mills
Choquan	20	18 700	6.70
Thu Duc 1	33	11 700	4.22
Thu Duc 2 & 3	132	11 400	4.16
Can Tho 1	33	11 700	4.46
Saigon Steam 1 & 2	250	10 800	3.89
New Steam 3 & 4	440	10 000	3.60
New Steam 5	330	9 800	3.53
Da Nang 1	25	12 000	4.56
Da Nang 2 & 3	132	11 400	4.35
Heavy oil diesels	96	10 000	4.00
Light oil GM diesels	100	10 700	11.20
Light oil gas turbines	58	17 000	17.70
Light oil province diesels	—	11 000	14.00 (average)

Total fuel oil prices are delivered costs to the Saigon terminal near Nha Be and a transportation cost for distribution elsewhere.

A heavy oil fuel price of US$16 per metric ton was used representing the average of prices in

the Saigon vicinity and a light oil price of US$46 per metric ton. The fuel oil prices were provided by VPC and reflect the price in effect as of July 1971 at an exchange rate of VN$275 to US$1.

2. Operating and Maintenance Costs

Operating and maintenance costs were calculated by using a unit cost per kilowatt for each size and type of thermal plant as shown on the following tabulation:

Plant	Rating MW	Annual O&M Cost US$/kW (Excl. fuel)
Existing		
Choquan	20	8.0
Thu Duc 1	33	5.0
Diesels & Gas Turbines	–	6.0
Under construction or proposed		
Steam Electric	25	5.0
Steam Electric	33	5.0
Steam Electric	66	4.0
Steam Electric	125	3.0
Steam Electric	220	2.5
Steam Electric	330	2.0

These unit cost estimates were selected after analyzing VPC actual cost for 1970 using an exchange rate of VN$275:US$1 and reviewing published costs from the US FPC and reports published by the Economic Commission for Asia and the Far East (ECAFE). Also considered were the estimated operating and maintenance costs submitted by Nippon Koei in its feasibility report for the 250 MW plant at Saigon and West Japan's report for the plant at Can Tho.

Estimated fuel, operating, and maintenance costs for the total VPC operations are summarized on Tables VI–10, VI–11, and VI–12 for Plans A, B, and C, respectively.

Generation Beyond 1986

As discussed elsewhere in this report, the development of the hydroelectric potential on the Mekong River will provide an abundant source of low cost power. Lengthy negotiations will be necessary to establish international agreements before construction can commence and this power source should be considered for long-range generation planning.

Large thermal plants will continue to have an important role in supplying economical base load energy near the load centers and when the system can support unit sizes larger than 500 MW, nuclear power may be competitive with conventional fossil fuels. This should occur about 1990 and by then research and design of nuclear plants should be highly developed producing new types of plants such as breeder reactors which are expected to produce lower cost of power.

TRANSMISSION AND DISTRIBUTION

General

The proposed program of constructing bulk power transmission facilities is geared to load requirements and the hydro development schedule. It will require large early expenditures but once these initial installations are completed, the burden of annual expenditures for bulk power facilities will reduce perceptibly.

In certain instances, the bulk power transmission circuits proposed will be serving the dual role of bulk energy transportation and tying outlying center groups into the main interconnected system. Distribution centers situated outside the Saigon metropolitan area are, for the most part, located in province capitals, chief towns, and independent cities, these being the more concentrated centers of population. Power for these centers is being generated principally by local limited capacity diesel units. Projections indicate that loads of 5 to 125 MW will be reached in most of these centers within the scope of this survey. In order to slow down continued proliferation of small diesel installations, an orderly program of extending subtransmission lines, when economically feasible, is required to gather these centers into interconnected groups and/or into the main interconnected system.

Subtransmission circuits are proposed to be extended in the early years to those centers more accessible to the larger generating sources and to those with greater potential for development. The program proposed in the expansion of transmission and subtransmission over the 15-year period will result in assimilating 41 of the present outlying centers into the interconnected system. At the end of this program, more than 97 percent of the total Vietnam projected load will be on the interconnected system.

Distribution systems of the usual substation primary feeder variety are constructed to supply local loads. Their design is not greatly influenced, as a rule, by the generating sources, particularly in interconnected systems. The initial design of a

distribution system serves to blanket developed and developing areas. Reinforcement and expansion of the system are anticipated to be a continuing process as load densities increase and as populations move outwardly. Many of the distribution systems now operated by VPC will require substantial rebuilding and all will necessarily be expanded to serve the anticipated loads of the next 15 years.

A basic plan for transmission has been developed and is used in all three system development plans. (See Figures VI–14 through VI–17.) However, timing of construction of the transmission lines is at a slower rate for Plan B as compared to Plan A and at a higher rate for Plan C. Also in Plan B, the distribution and subtransmission development is assumed at a slower pace consistent with the lower rate of load growth.

Tables VI–13, –14, and –15 indicate the estimated unfinanced cash flow for construction of all transmission and distribution facilities proposed in the program. The costs for projects already financed are not included in the tabulations.

Estimated annual operation and maintenance costs for transmission and distribution are in Table VI–16.

Transmission Plan

So far, one long distance transmission line (230 kV) approximately 257 km in length has been constructed in Vietnam for transmission of large blocks of power. By 1986, it is projected that the VPC system demand will increase to more than eight times its present magnitude. Bulk power transmission facilities proposed to satisfy this need involve construction of approximately 1 375 km of new 230–kV lines which, with associated substations stepping to lower voltages, will represent an overall investment of approximately US$92 million. The following details relate to the major transmission projects shown on Table VI–17, –18, and 19.

Da Nhim–Saigon Line Restoration

The Da Nhim–Saigon line which has been out of service since 1965, must be repaired in order to transport power from the Da Nhim hydroelectric plant, about 20 km southeast of Dalat, to the Saigon metropolitan interconnected system. The date established for making this 160–MW source again fully available to the system is January 1974. A survey of work to be done is expected to be made soon by Japanese consultants with a view to reconstruction of damaged towers and necessary conductor work to be completed in late 1973. VPC has estimated the approximate cost of the work to be US$1.49 million for restoring the line to service by the target date.

Saigon Substation–Phu Lam 230–kV Line

The first of two 125–MW thermal generating units is planned to go in service by mid-1975 to furnish required energy for the integrated loads. It is proposed that this plant be situated on the Dong Nai River, south of Saigon, at a location identified as Nha Be in Figure VI–19. The proposed method of tying this generation into the system is to construct a 230–kV circuit, approximately 32 km in length, from Saigon Substation looping through the new Nha Be plant and on to Phu Lam on the westerly extremity of the city. This tower line should be designed so it will be suitable for a future second circuit. The present four 66–kV lines from Saigon Substation which terminate at Cholon Substation are to be extended from the substation vicinity to a new 230/66–kV source to be established as part of the project at Phu Lam. Cost of this improvement has been estimated by VPC at US$4.55 million with expenditures spread over two years terminating in mid-1975.

Saigon–Can Tho 230–kV Line

Capacity of a new 33–MW thermal plant proposed for Can Tho will be completely saturated by mid-1975. Under phase two of the Can Tho project, it is planned to install a second 33–MW unit of generation at the site in 1975 and complete the extension of subtransmission to additional province centers. In lieu of a second small unit at this location, it is proposed that a 230–kV transmission line be extended from Phu Lam Substation at Saigon approximately 130 km to Can Tho with transformation at Can Tho to subtransmission. This plan will permit utilization in the delta area of more economical energy from the large thermal and hydro installations of the interconnected system. In addition, the latter solution will be adequate for a number of years, whereas a second 33–MW unit would become inadequate within one or two years, at the most, if the projected growth is realized. Costs for this project have been estimated on the basis of constructing 130 km of single circuit steel tower line and terminal facilities at each end including the transformation at Can Tho. Design and engineering are proposed to start in the latter part

of 1973 with line completion by mid-1975. Cost of the project is estimated at approximately US$5.6 million. Another possibility could be the installation in Can Tho instead of Saigon of the 125–MW unit proposed for completion in 1976. The proposed transmission line would provide a back-up until the 125–MW unit was in service.

Saigon 230/138–kV Substation

As part of the program to extend subtransmission lines to the province centers and to distribution substations on the perimeter of the Saigon metropolitan area, a 138–kV source is required at Saigon Substation in 1975. The first use of this source will be for a circuit to Vung Tau Substation and another to the town of Phuoc Le. It is proposed to install in Saigon Substation, a 230/138–kV transformer with sufficient capacity later to serve large substations in the industrial zones adjacent to the east and north. This source is planned to be made available at an estimated cost of US$1.05 million for service in late 1975.

Da Nhim Extension–Saigon 230–kV Line

Da Nhim hydro extension is planned to be developed to provide power to the interconnected load by mid-1976. Connection of this 106–MW source to the Saigon area is proposed to be via a new transmission line approximately 265 km in length from the plant southeasterly to a point which would lie in a direct line between Saigon and Cam Ranh, thence southwesterly along this line to Saigon with termination to be at the new Nha Be thermal plant. The section of line between Saigon and the future Da Quayon 1 site is proposed as a double circuit facility. Remainder of the line will be single circuit. The double circuit construction is selected as being more economical than two separate single circuit installations in view of the proximity in timing of this project and the need to provide transmission facilities for the subsequent Da Quayon development.

Alternate routes were considered for this line, notably one which would follow a course from Da Nhim southeasterly to near Phan Rang, thence southerly along the coastal plain to near Vung Tau and on to Saigon. This alignment had the assumed advantages of greater security, easier accessibility for construction, and the prospects of future development along the coast which might at sometime be served from the new line. Further analysis, however, has shown the cost differential between a direct route and the coastal route to have an effect of approximately US$11.5 million on the overall transmission plan in favor of the former. Not only is the direct route much shorter but the increased capacity of the shorter circuit appears to obviate the need for an additional line from Saigon to Da Quayon which was anticipated to be required at a slightly later date if the coastal route were chosen. Coastal cities from Vung Tau northward are expected to be adequately served for many years from the proposed 138–kV line double ended at Saigon and Da Quayon Plant 2 which is proposed as part of the interconnected system expansion to include provincial centers. It is hoped that security will be established by the time construction should begin on the Da Nhim Extension line; in event this should not be the case, then the coastal route might be reconsidered. Construction is anticipated to begin in 1974 and be completed by mid-1976. The estimated cost of US$19.1 million includes terminal facilities at each end of the line.

Saigon 230–kV Loop

A second 125–MW thermal unit is planned to be installed at Nha Be Station and ready for service in mid-1976 coincident with completion of the Da Nhim Extension project. In order to properly distribute this input and the generation being fed into Saigon Substation from Da Nhim No. 1 hydro and the Thu Duc thermal units, it is proposed that a 230–kV loop be completed around Saigon as shown in Figure VI–19. This loop, which becomes the backbone of the metropolitan transmission system, will be required to handle reinforcement of the 66–kV system from additional points, input from future large hydro and thermal units, and for supply to loads of 200–600 MW external to the loop within ten years. For adequacy in serving these purposes and for improved reliability, this new facility is proposed to be a double circuit steel tower line with both circuits installed initially including installation of the second circuit in the Saigon Substation–Phu Lam portion via Nha Be Station. Increased 230/66–kV transformer capacity at Saigon Substation is also provided as part of the project. Estimated cost for this improvement is US$6.62 million with construction in 1975 and the first half of 1976. Should the second 125–MW unit be installed in Can Tho instead of in Nha Be Station, the Saigon 230–kV loop would still be needed.

Da Quayon, Stage 1, 230–kV Tap

Da Quayon hydro first development will produce 270 MW and energy for the Saigon area beginning in mid-1978. In order to connect this source to the system, a 230-kV tap is proposed from the plant to the second circuit of the double circuit line constructed in conjunction with the Da Nhim Extension project. Input terminal to the Saigon 230–kV loop is at Nha Be Station. This project will require approximately US$1 million to be expended in 1978.

Hoc Mon Substation–Nha Be Station 230/66–kV

Reinforcement of the 66–kV circuits between Saigon Substation and Phu Lam Substation will be required shortly after the load level in Saigon reaches 750 MW. This need was noted by Sanderson & Porter in connection with their power flow analysis carried out in developing plans for transmission and distribution improvement in the Saigon–Cholon area. A load level of this magnitude is expected to be reached or exceeded by the end of 1978. To effect the necessary relief to the 66–kV circuits, it is proposed that two additional 230/66–kV stepdown substations be established in the 230–kV loop. One of these is proposed to be located at Nha Be Station, and the second at a new site shown as Hoc Mon in the 230-kV loop north of Tan Son Nhut Airport. Four, 66–kV circuits will be extended from each of the new transformation points to intercept and divide the present four 66–kV lines. Hoc Mon Substation is planned and located for later use as a terminal for incoming lines from hydro plants including a possible EHV connection. Construction of these two substations is expected to cost about US $ 5 million with the work to be accomplished in 1977–78.

Da Quayon 1, Stage 2, 230–kV Tap

Further development of Da Quayon hydro potential will make an additional 270–MW capacity available in mid–1979. It will be necessary at that time to arrange a tap from the plant to the original Da Nhim Extension circuit. It is expected that local requirements in the Dalat–Cam Ranh area will by this date saturate the Da Nhim Extension capability and that this circuit to Saigon will be fully available for Da Quayon Stage 2. Estimated cost is US$0.7 million with construction concluding in mid–1979.

Phu Lam 230/138–kV Substation

It is proposed under the Saigon metropolitan subtransmission and distribution program to utilize 138 kV as supply to those distribution substations outside the 230–kV loop and for extension to the provinces. In 1979, a new substation is anticipated to be required on the northwest side of the city outside the belt highway. In order to make 138 kV available for supply to this new distribution substation and to additional future substations, it is proposed to install under this project a 230/138-kV transformer and switchgear at Phu Lam Substation which was established earlier in this program in the west side of the 230–kV loop. Additional details of the subtransmission work are found in that section relating to the Saigon metropolitan area. This new source to be made available in late 1979 is expected to cost approximately US$1 million.

Tri An, 230–kV Line

Additional energy required for the interconnected system by January 1981 is proposed to be provided by a new 120–MW (ultimate 240 MW) hydro plant at Tri An located approximately 50 km northeast of Saigon. This project is to construct a new 230–kV single circuit tower line for transporting the energy from Tri An to Hoc Mon Substation at Saigon in the north side of the Saigon loop. Cost of the line and substation facilities is estimated at about US$3 million with construction planned to be over a two-year period.

Da Quayon 2, 230–kV Line

Development of Da Quayon Plant 2, and additional 100-MW source located between Da Quayon 1 and Phan Ly, is planned to be completed by early 1981. To connect this generation to the system, it is proposed to install a 230–kV circuit approximately 25 km in length from the new plant to Da Quayon 1. At this latter point, a tie will be made to the existing Da Nhim Extension circuit. Power from the Da Nhim Extension hydro is expected to be insufficient for the local subtransmission system by this date making circuit capacity available for this addition. Construction is planned for 1979–80 at an approximate cost of US$1.7 million.

Thu Duc (Saigon) 230/138–kV Reinforcement

Load growth on the 138–kV subtransmission circuits proposed to be served from Saigon Substation is expected to require additional 230/138–kV transformer capacity at this source by 1982. It is proposed that an additional

transformer be installed with switching facilities suitable for looping 138–kV circuits through the anticipated heavy load concentrations in the Bien Hoa–Long Binh area. Estimated cost for the improvement is about US$1.6 million programmed for 1982.

La Nga–Saigon 230–kV Line

The first stage of La Nga, a 90–MW hydro source located southwesterly from the Da Quayon site, is to be developed for service beginning January, 1984. In order to transport this power to the interconnected system, a double circuit steel tower line is proposed from the site by a direct route to Saigon. This line, approximately 150 km in length with one circuit installed initially, will provide a position for a second circuit when the remaining 335 MW potential at this site is expected to be required by January, 1989. In connection with this new circuit, it is proposed for better distribution of power into the Saigon loop and to avoid crossing over of tower lines to rearrange circuits as they approach Saigon from the northeast. The original Da Nhim circuit would be carried westerly to Hoc Mon Substation for termination. One circuit of the Da Nhim Extension line would pick up the stub of the original Da Nhim line and terminate at Saigon Substation while the second circuit of Da Nhim Extension (Da Quayon) line would continue to terminate at Nha Be Substation. The new circuit from La Nga would then replace a Da Nhim Extension circuit at Nha Be. The new arrangement is illustrated in Figure VI–20. The construction cost estimated at US$10 million is proposed to be spread over three years.

Song Ba–Da Nang 230–kV Line,

Song Ba–Phan Rang 230–kV Line

Song Ba, a 150 MW hydro installation, is proposed to be completed by January, 1985 at a location approximately 60 km northwest of Qui Nhon. Power from this development is required both in the Da Nang area and in the interconnected system to the south. In order to meet both needs, a 230–kV single circuit steel tower line is planned to be constructed from the new plant northerly a distance about 260 km, paralleling the coastline, for the most part, to Da Nang. A 230/138–kV substation for input to existing subtransmission will be constructed at Da Nang. In addition, a second single circuit 230–kV steel tower line will be necessary from Song Ba southerly along the coast to a point northwest of Phan Rang, approximately 315 km to the south where a tie will be made to the prior existing Da Nhim Extension circuit with sectionalizing at this location. This will make the northern sector a part of the interconnected system. At this time this latter circuit is extended, it is also proposed to install a 230/138–kV substation at Cam Ranh or at Nha Trang to reinforce the local subtransmission system in this area. Total demands from Phan Rang north at project time are expected to be such that most of the generating capacity north of this point will be absorbed in supplying the local requirement, and the new tie will be transporting some power northward until the next unit comes on. Cost for this project is estimated at US$22.4 million programmed over five years of construction time.

Yali–Song Ba 230–kV Line

A 200–MW hydro development at Yali is proposed to be available for service in January, 1986. This first stage can most readily be connected to the system by extending a 230–kV single circuit steel tower line from Yali easterly 110 km to Song Ba with switching facilities at Song Ba. A subtransmission source will also be included at Yali to serve approximately 30 MW of load in Pleiku, Kontum, and Phu Bon. Assessing the expected loads at that time, it appears there should be available from the northern group of hydro and steam units including Da Nhim Extension but not Da Nhim 1, approximately 130 MW for a time toward Saigon. The project estimate is US$6 million over a three-year construction period.

Included in the last year of this program are estimated costs for engineering and design work to be undertaken for new circuits required to bring additional power into the grid at a time beyond the scope of this study from La Nga and Upper Se San hydro installations. This preliminary work will have to be started to meet anticipated in-service dates.

The proposed system of transmission lines outlined above is believed adequate for the loads anticipated within the study period. Computer studies have not been conducted to verify this, however, and various assumptions have been necessary. Consequently, it is recommended as an important part of engineering and design plans for any of the proposed circuits that a thorough analysis be made prior to implementation or commitment of any work. Should additional capacity be required in any of the circuits, the application of series compensation should be considered.

It is suggested that any future long-range planning of the transmission system for Vietnam include periodic review of the projects outlined in this proposed program. Analysis of possible benefits of future higher transmission voltages would be a proper part of such reviews. As system growth patterns begin to show firm trends and as area developments take place, the plan should be kept flexible enough to accommodate the needs.

Subtransmission and Distribution Plan

Saigon Metropolitan Area

The Saigon metro area subtransmission and distribution systems presently supply a peak load of approximately 200 MW. It is expected that this load will increase more than eight times to about 1700 MW within the fifteen years viewed in the survey. A major task is involved in the expansion of the systems at a sufficiently rapid pace to cope with this load growth, which, in the early years (1972–76), will be accelerated to satisfy an estimated 115 MW of pent-up demand.

1. Subtransmission

Subtransmission source at 66 kV is from Saigon Substation adjacent to the Thu Duc plant approximately 10 km northeast of the city. From this location, the 66 kV is looped around the more heavily populated area and through five 66/15–kV substations. Three additional substations are situated in the loop. Overall substation transformer capacity is 272 MVA. A 230–kV line from the Da Nhim hydroelectric plant also terminates at Saigon Substation and for a period supplied energy to the loop via 230/66–kV transformation. Arrangement of circuits and approximate location of existing substations are indicated in Figure VI–18.

After the hydro source was lost, diesels were brought in to make up the deficiency in generation. These units connect to distribution buses in 66/15–kV substations and in remote switching stations at fourteen locations throughout the system. As a result of this large block of direct generation input to distribution (129 MW available), the present loading on 66–kV supply and substation transformers is greatly reduced.

Growth in the very early years of the forecast is expected to concentrate in the already heavily populated portions of Saigon and Cholon where extremely crowded living conditions now exist. It is believed, however, that the city will begin to expand outwardly as security and economic conditions improve. A major factor expected to influence growth outwardly of both residential and commercial enterprises is greatly improved access by way of a newly completed belt highway surrounding the westerly and northerly portions at a distance of 8 to 12 km from the central business district. It is in these outer areas, also, where suitable land for such purposes is reportedly most available.

Industrial development is expected to accelerate in the Bien Hoa, Long Binh, and Thu Duc areas north and northeast of the city where industrial parks have been concentrated and where access is via the Bien Hoa Highway, a major artery. Other likely industrial sites are in the areas bordering the city to the south and southwest and in the Hoc Mon sector northwest of Tan Son Nhut Airport.

Consideration has been given to these and other factors in attempting to foresee the likely development of load areas geographically and their probable demands in making an assessment of the magnitude of subtransmission and distribution facilities required for adequate service for the 15-year period. The Saigon metro area maps (Figures VI–18 through VI–20) show, at intervals, the approximate location of substations and arrangement of subtransmission circuits visualized in development of the system costs.

It should be emphasized that this plan is conceptual only; that it cannot possibly be followed in all aspects as presented for the 15 year period; that prior to making final decision on implementation of any facet, a more detailed study must be made of that portion and its relation to the overall plan; and finally, that periodic reviews should be made of the plan, editing and updating it in the light of more and better information.

At this point, it is desired to recognize the recent study and plan which Sanderson & Porter, Inc., consulting engineers, have prepared for reinforcement and expansion of the transmission and distribution systems of VPC to serve increased loads in the Saigon–Cholon area.[3] This work has been reviewed and adopted in large measure as a basis for the longer range plan required for the NPS. The early steps which have been recommended are reiterated in part for the

[3] Sanderson & Porter, Inc., *Transmission and Distribution Program for Vietnam Power Company – Saigon-Cholon Area Development* Prepared for USAID under Contract AID/vn–88. May 1971. All references to and quotations from a Sanderson & Porter study are from this report.

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purposes of continuity and overall clarity in the construction schedule, maps, and discussion.

Reinforcements in the first years of the program are designed to permit utilization of more economical energy from Thu Duc thermal units 2 and 3, gas turbines, and new installations of 96 MW in heavy oil diesels while reducing participation of the old, portable GM diesels.

Phase 1 of Sanderson & Porter's plan proposes the installation of new substation "A", construction of a 66-kV line segment between Xa Lo Substation and Cholon Substation, enlargement of Ba Queo Substation, modification of Cholon Substation, and, in addition, expansion of the distribution system. The line construction results in a third 66-kV circuit between Saigon Substation and Cholon Substation. This phase of the work was planned to be completed by December 1972 to provide the necessary capacity for utilizing the new thermal generation at Thu Duc which is expected to be available at an even earlier date.

The second phase of the Sanderson & Porter plan is to complete a fourth parallel 66-kV circuit between Saigon and Cholon Substation by closing between Ba Queo Substation and a tap point on the existing circuit between Saigon and Xa Lo Substations. The new line section would be routed around the west and north sides of Tan Son Nhut Airport. The section of the circuit between Cholon and Ba Queo Substations is small conductor which will be replaced as part of this project. New substation "B" is proposed to be located in the Go Vap district on this new line section, northeast of the airport, for relief to 15-kV feeders now serving that area. A second section of 66-kV line is to be constructed from Saigon Substation to Xa Lo Substation by a route internal to the present 66-kV lines which, with a short loop through new substation "C" also required at this time near the central market area, will complete a fourth 66-kV circuit between Cholon and Saigon Substation to the Bien Hoa-Dong Nai area to separate these substations and relieve the present circuit which is expected to be inadequate by the time a 400-MW load level is reached. In connection with installation of the new circuit, it is suggested that consideration be given to future upgrading to 138 kV by providing insulation and spacing if this can be accomplished reasonably at the time. A further expansion and reinforcement of the distribution system is also part of the second phase. Construction on this phase is expected in year 1973.

In connection with restoration of the Da Nhim power source in 1974, a final phase of Sanderson & Porter's program plans continued expansion of the distribution system to handle this additional input. It is suggested in addition to the work proposed for year 1974 or for the following year that consideration be given to replacing the Bien Hoa and Dong Nai 20 MVA transformers with 30 MVA or larger units, dual rated for 69/138/15-kV and that the 20 MVA units salvaged be installed, one each at Xa Lo and Ba Queo where it is expected that load growth will have overtaken capacity, particularly in view of the program to relocate the portable diesel units to the provinces. Dual rating for the Dong Nai and Bien Hoa units is proposed to facilitate later upgrading the subtransmission source in these areas of anticipated heavy loads.

A new thermal plant proposed to be located in the Nha Be area will connect to the Saigon integrated system in 1975 via 230-kV lines proposed to terminate at Saigon Substation and at a new substation on the southwesterly extremity of the city designated as Phu Lam to provide reinforcement for the expected rapid load buildup on these lines and to properly allocate power from the new thermal plant to the system.

Additional substations are anticipated to be required in year 1976 at approximate locations designated "D" and "E" in Figure VI-19. An additional transformer also appears necessary at each of three substations in the 1976-77 interval to accommodate load growth at locations noted on the construction schedule.

The Saigon metropolitan area load level is expected, by year 1978, to exceed 750 MW. Load flow studies made by Sanderson & Porter indicated the need for further reinforcement of the 66-kV system when this level is attained. Actually, at the level of 750 MW as examined, there was still an appreciable contribution indicated from diesel other than the new heavy oil units now being installed. This would indicate that a program of aggressive relocation of the old units to centers outside the 66-kV network may bring about need for this reinforcement at an even lower load level in an earlier year. Relief is planned to be obtained by installation of two additional 66-kV sources, one at Nha Be station, the other at a new substation designated as Hoc Mon in the 230-kV loop north of Tan Son Nhut Airport. Four 66-kV circuits are proposed to be extended from each of these new sources to intercept and divide the existing four circuits into eight. Details of suggested rearrangement may be

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seen by reference Figure VI–20. It is recognized that parts of the routes indicated or in fact any route which might be chosen to reach a desired intersecting point with these prior existing circuits may be difficult to achieve with overhead construction and it may be necessary in some instances to resort to underground cable to attain the objective. This reinforcing step is believed to be sufficient to sustain the inner city 66–kV system for a considerable time in view of expected acceleration of growth outwardly which is proposed to be taken on the 138–kV subtransmission.

Three additional substations "F", "G", and "H" are expected to be required in 1978 as is an additional transformer at location "D".

The first 138 kV on the west side of the city is anticipated to be required by 1979 and is proposed to be supplied from a new transformation at Phu Lam with a line extended to location "J".

Additional substation capacity which is expected to be required in later years is, in a number of instances, either an additional transformer in an existing substation or a new substation involving little or no line work as is the case in years 1980–81.

A major improvement visualized for years 1982–83 is closing of a 138–kV loop supply from Saigon Substation through the substations and industrial park areas of the Bien Hoa sector. Load density in this developing area is expected to become very heavy with dual feed and high-voltage service required by some customers. The present two circuit 66–kV towers may be suitable for modification to 138–kV double circuit or, if not then, for single circuit with the second circuit being carried on a separate pole line and serving provincial loads beyond the Bien Hoa development. The other side of the loop can be comprised of the original 138–kV circuit extended for service to the province areas which, at the time of this project, is expected to be the supply for two of the substations proposed to be served from the 138–kV loop. As load patterns develop in this area, the alternative of a 230–kV to 138–kV transformation somewhat farther out may be worthy of consideration.

It is anticipated that with the addition of substation "S", northwest of Thu Duc, near the end of this program, the 138–kV circuit northerly from Phu Lam will be extended to substation "M" at Lai Thieu making two-way feed available for three substations outside the belt highway in the westerly sector.

All projects envisioned for 1985–86 involve either additional substations on existing lines or additions to prior existing substations. Figure VI–20 shows the system as visualized at the end of the 15-year period. It might be noted at this point, that while attention has been given to maintaining sufficient capacity to meet the projected loads, there will be cases where capacity in certain areas will be tight at times simply because from a practical standpoint a fine balance between substations cannot always be attained. The system has deliberately been planned to have little excess transformer capacity. It is, however, urged that the subtransmission lines, particularly those new sections being constructed inside the 230–kV loop, be erected initially with large conductors, e.g., 954– or 1033– M.cmil aluminum. Procurement of rights-of-way, being increasingly costly, make it prudent to consider somewhat increased initial costs. Conductors of this size should impose no undue burden on wood poles of proper class nor on hardware in the Saigon climate where ice loading is not a factor.

The overall addition to distribution substation capacity as proposed in this program is 1500 MVA or 50 units of 30 MVA each of which will bring the total installed capacity to 1772 MVA as related to the expected Saigon metro area peak of 1770 MW in year 1986. Customer loads expected to be served at 66 kV or higher voltage were estimated to reach 300 MW by that time. Assuming 90 percent load factor, the ratio of peak megavoltampere on the distribution substations to installed capacity is 0.88. This margin is small but should in the overall be sufficient particularly when the short-time overload capability of transformers is considered. The program as presented is believed flexible enough to permit either acceleration or deceleration as actual rates of growth become evident.

2. Distribution

The present primary distribution system utilizes two voltages: 6.6 kV in the older portions and 15 kV in those more recently constructed. All of the 6.6 kV and a considerable portion of the 15–kV circuits are direct-buried cable there being no conduit system other than for street crossings. Overhead pole line construction has been used in recent years for 15–kV primary and is planned by VPC to be greatly expanded in meeting load growth in the future. Information

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supplied by VPC indicates approximately 186 km of 6.6–kV and 308 km of 15–kV underground circuits and 230 km of 15–kV overhead lines in the present system.

The 15–kV feeders exit from the eight substations of the 66–kV system, some of them supplying load directly but, in other instances, they serve as transport feeders to remote switching stations. At these remote 15–kV buses, a portion of the supply, in some instances, is transformed to 6.6 kV and distributed at the lower voltage; the remainder is divided at these same buses into additional subfeeders at the 15–kV level. Supplementing the supply from the 66–kV sources are the diesel installations connected, in some instances, to distribution buses in the 66–kV substations and in other cases, input is via transport feeders to 15–kV buses in the switching stations. At Choquan Substation, diesels also input to 6.6–kV buses. There are several locations where overhead circuits are supplied through 1/1 isolating transformers from the 15–kV underground cables.

Secondary lines are 120/208 volts, three-phase four-wire, or 220/380 volts, three-phase four-wire, the former predominating. Secondaries are carried on pole lines with open wire construction. Poles are a variety of concrete, wood, and lattice-type steel structures. Separate three-phase street lighting circuits are, for the most part, carried on the same poles with the secondaries.

Transformers on the underground system are installed in masonry buildings or cabines which also house sectionalizing switches for the underground cables. In the newer overhead construction, transformers have been placed on platforms of H-frame design. Transformers are all three phase and of a relatively large size with more than two-thirds of approximately 1600 units in service being 200 kVA or larger.

A rather elaborate system is employed for check purposes on both cabine and platform-mounted transformers wherein the secondary output of each unit is metered. Street lighting circuits are also metered for billing purposes in the cabines where the switching is controlled by time clocks.

Secondary runs are observed to be long and of small conductor size in most instances; similarly, service loops are of small size with the net effect being low-voltage conditions in widespread areas. VPC reported, for example, in March 1971 as quoted by Sanderson & Porter that in 531 instances voltages on 120/208-volt secondaries at peak load were in a range of from 95 to less than 80 volts and an additional 231 were reported as being 95 volts and over. American National Standard recognizes 110 volts as the minimum tolerable service voltage for this system.

Sanderson & Porter's plan for expanding capacity of the distribution system includes proposals for converting the present 15–kV three-wire system to four-wire with common neutral, containment of the present 6.6–kV system by taking new loads on 15–kV and gradually cutting back the 6.6–kV with 15–kV as failures occur or by conversion of the extremities when relief is required. Utilization of single-phase transformers, connected phase to neutral as proposed, will simplify primary extensions and reduce costs in the many instances where three-phase services are not required; this should also prove a distinct aid in extending primary into alleys and narrow ways for the purpose of bolstering presently inadequate secondaries where single phase will suffice. Replacement of the old 6.6–kV system with new 15–kV over a period of time will serve to improve operating records in addition to substantially reinforcing capacity in the areas of high load density.

Sanderson & Porter's program for reinforcing the cabine service areas would shorten the secondaries fed from these vaults by extension of primary lines on wood poles, installation of pole mounted transformers, and cutting back length of the runs from cabines by assignment of sections of secondaries to the new overhead transformers. It is not planned under this approach that secondary conductors be replaced.

Problems of high temperature in some "cabines" are apparently the result of heavy transformer loading. In this respect, the transmission and distribution program of reinforcement should result in considerable relief as provisions to reduce loading on most of the cabines are included. Additional cooling for those remaining stubborn cases, where the natural stack ventilation is not sufficient or cannot be made so, can most satisfactorily be obtained by installing forced ventilation as proposed.

Further recommendations have been made in connection with installation of the 33 MW of new diesels at Choquan to revamp this substation, relocating the 15–kV switchgear outside the switchhouse and providing for additional power from the Chanh Hung-Choquan Substations. Use of the transport feeders to serve load wherever possible is proposed as is radial operation for

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both overhead and underground feeders.

Extensive improvement and modernization of the street lighting system has also been recommended as part of the current transmission and distribution program. The key to implementation of this improvement, however, lies in successful negotiations with the city to permit flat rate rather than metered energy billing for the service. Once this has been accomplished, it will be feasible to remove the duplicate street lighting secondaries and replace the luminaires with modern mercury units with photo-control directly from the street secondaries.

There is obviously a great need for improved street lighting in much of the city from the various aspects of safety involved. Accomplishment of this goal will be a most significant item in making possible a cleanup of the overhead pole lines. Development of an overall plan for street lighting, with proper attention to lighting levels appropriate for various classes of streets and traffic situations, will assist the city officials responsible for authorizing additional lighting in making their decisions. VPC will also benefit from the standpoint of being able to coordinate new construction work with future street lighting requirements.

Plans and additional details for implementing reinforcement and expansion of the distribution system to a capability of 450–500 MW are now under study by Sanderson & Porter. A continuating distribution expansion on an orderly basis in keeping with load growth will be necessary to provide service to all applicants. The program outlined by the consultant has been thoroughly reviewed and the principles advanced appear reasonable and suitable for extrapolation to meet the needs of much greater load levels expected in the future.

In harmony with the subtransmission and substation expansion program outlined in the earlier portion of this section, it will be necessary in the 15-year period to construct, at a similar rate, distribution feeders, local primary and secondary lines, and distribution transformer stations and to install the ultimate service connections for an estimated additional 388 000 households plus other commercial and industrial loads representing an eightfold increase in present load. A minimum capacity of 160 new 15–kV feeders with all appurtenances will be required to satisfy the requirement of this period. Subtransmission and distribution projects are shown on Table VI–20.

Provinces

Ultimately, most of the province centers, for overall economy, should be supplied from the interconnected system. Distances between these centers range from 30 to 60 km for the most part. Coupled with the anticipated loads which are expected to continue growth beyond the study period, it is recommended that 138 kV should be considered for supply. Early reinforcement or upgrading of lines is, in general, uneconomical and would become necessary in some instances on lines proposed to be built to the centers if 66 kV were selected. Additional capital outlay for 138 kV is approximately 15 to 20 percent over that for 66–kV lines and substations. Capacity at 138 kV is double while losses and percent regulation are reduced to one-fourth as compared to the lower voltage. An opportunity is available now at the outset of the program to standardize on 138–kV supply to all distribution substations outside the Saigon metropolitan area. It is recommended this step be taken in the interest of being able to realize the full normal life of pole lines and transformers.

VPC has a number of projects planned to initiate the upgrading of service to outlying centers and integration of them into the larger sources. The projects have been reviewed and are included in the program for the 15-year period, approximately in the order and schedule as proposed by VPC. Details of four of the major VPC projects follow:

1. Da Nhim hydro plant will be restored and available for service in 1973. It is planned to extend subtransmission circuits from Da Nhim to Dalat, Phan Rang, and Cam Ranh to supply a substation at each location. Total load to be served by this development is 15 MW, initially. These centers will then become part of the integrated system load upon completion of the 230–kV Da Nhim–Saigon line restoration anticipated for 1974.

2. A 25–MW steam plant is planned to go in service at Da Nang in the northern sector in January 1974. Along with this, it is proposed to extend subtransmission lines to Hue and subsequently to Hoi An, Tam Ky, Quang Ngai, and Quang Tri. This will interconnect the six provincial capitals of the area. It will be necessary soon thereafter to augment the Da Nang generation with interim diesel until a more permanent reinforcement can be brought on line.

This interconnected group will continue to operate as a separate system until 1985 when it will be interconnected to the integrated system. Load of this group in year 1978 is expected to aggregate 103 MW.

3. A new 33–MW steam plant is expected to be in service in 1974 at Can Tho. In connection with this installation, a two-stage transmission project is to be implemented to deliver power to substations at the centers in the prosperous delta region. The first step is designed to extend central station power to Binh Thuy, Vinh Long, Long Xuyen, Rach Gia, and Sa Dec centers from Can Tho. Initial combined load will be approximately 31 MW. A second phase of extensions will raise the Can Tho load to 59 MW in 1975 when additional substations at Ba Xuyen, Bac Lieu, Ca Mau, Chau Doc, Vinh Long, and Tra Vinh are connected. In order to meet this requirement, a 230–kV transmission line is proposed to be extended from Saigon to Can Tho to supply the generation deficiency from the interconnected system or a combination of the line and additional generating capacity at Can Tho.

4. Extension of a subtransmission line to substations at Phuoc Le and Vung Tau on the South China Sea, approximately 97 km east of Saigon, is planned for service in 1975. The load at that time is expected to be 7.5 MW. Further extension in 1979 will gather an additional 11 MW from Ham Tan and Phan Thiet further up the coast into the integrated system.

It should be noted in connection with the above projects that 66–kV subtransmission is contemplated in the original plans. There should be no difficulty in revising this to 138 kV in any case except possibly the first phase of the Can Tho project. The other projects may be revised prior to bidding in the time available. It is urged that phase one of the Can Tho project be negotiated so that the beginning of the backbone of the delta area subtransmission can also go in at 138 kV to obviate the need for early reinforcement.

Subtransmission lines will be extended to other province centers on the average of one or two a year as loads grow. Over the 15-year period, 41 of these centers are proposed to be connected to subtransmission supply, two will remain isolated and supplied from local generation. The magnitude of load gathered to the interconnected system in the provincial program is expected to aggregate 919 MW by year 1986.

The approximate overall cost for interconnecting these centers is US$55 million for extension of 2000 km of subtransmission wood pole lines and construction of 47 distribution substations.

Table VI–21 indicates the proposed order and magnitude of provincial center loads transferred to the interconnected system. The order of projects gathering certain centers for the purpose of developing other interconnected groups prior to their becoming part of the integrated system is shown in Table VI–22. A proposed construction schedule for lines and substations is summarized in Table VI–23. Figures VI–14 through VI–17, show at five-year intervals, the development of bulk power delivery and subtransmission lines in the province areas.

Completion of the proposed program will result in extending the benefits of mass generation of electric power to more than 97 percent of all load outside the Saigon metropolitan area as projected for the year 1986.

Rural

Service to the rural areas will consist primarily of lines to hamlets and villages where the houses are concentrated. Few people live on the land that is cultivated. Instead, they congregate in small groups, which results in the concentration of load into small areas with distances of several kilometers between load groups.

As all-weather roads are built in the delta area, new houses are built along the roads and the old houses along the rivers and canals are abandoned. This same trend of building along the new improved roads will take place in the higher areas, especially where electric lines are constructed along the roads.

The desire for electric service in rural areas is demonstrated in a summary prepared by VPC. In 156 hamlets in 26 provinces, small groups of people or, in a few cases, the village or province have obtained small engine-driven generators to furnish electric service for limited periods each day. These units total 5928 kW with the majority in the 15 kW to 30 kW size. There is no information on the amount of energy developed. The distribution systems were built by the owners of the generating units and are at secondary voltage without any primary line.

VPC has started to meet this demand by ordering a number of diesel-driven generators to be installed in cities, province centers, and district centers to be used until the bulk power transmission system is constructed.

On September 14, 1971, the Director of USAID entered into an agreement for rural electrification with the Office of the Prime Minister representing GVN.

The project, which was initiated in the US fiscal year 1965 is in two phases. Pertinent parts of the Agreement are quoted at length since it establishes fundamental national policy with respect to electric cooperatives.

The first or pilot stage ". . .was to (1) establish three economically viable pilot electric cooperatives in rural areas for use as developmental models in planning the expansion of electric cooperative activity; and (2) establish an economically viable pole treatment plant that will eventually meet the requirements of the rural electric cooperatives and the Government of Vietnam (GVN) for treated poles and crossarms.

"The second (operational) phase is to (1) promote the establishment of additional electric cooperatives and expand those already in existence; and (2) establish a revolving loan fund under which repayments from the three pilot cooperatives, the National Union of Electric Cooperatives (NUEC), and the Vietnam Power Company (VPC) may be used for loans to establish new cooperatives and expand existing cooperatives. This revolving fund, to be comprised of payments on loans of US dollar grant and counterpart piastre financing since the beginning of project funding in 1966, will be referred to in this Agreement as the Rural Electric Cooperative Fund (RECF). The RECF will be established as an account in the present Development Fund which is controlled by the Minister of Public Works."

At the end of April 1971, the status of the pilot stage was as follows:

All three rural electric cooperatives had been established using funds borrowed from GVN and made available to GVN for this purpose by a USAID grant.

The Duc Tu Cooperative in Bien Hoa Province had completed its work with 10 498 members connected compared to a target estimate of 7400.

The Tuyen Duc Cooperative in Tuyen Duc Province was 35 percent complete with 893 members receiving electricity and 600 members connected but without power as against 5400 targeted to receive power.

The An Giang Cooperative in An Giang Province had completed its work with 13 121 members as against 13 121 targeted.

VPC is supplying the power to two of the cooperatives from power plants constructed by VPC using US-funded loans from GVN similar to the cooperatives' funding arrangements.

The pole's treatment plant (PTP), located at Phan Rang, was completed in 1968, and is being operated by NUEC primarily to serve the needs of the member cooperatives for treated wood poles and related wood products. The PTP was also financed by a US-funded loan from GVN.

The Agreement provides for the completion of the pilot phase and identifies the responsibilities of the parties concerned with the operational phase.

The Minister of Public Works, who was responsible for the pilot phase, is also responsible for the operational phase using the Chairman of NUC as his project manager. The Minister is to provide technical assistance as needed by the cooperatives, including any subsequent cooperatives, to assist in the organization and construction of suitable physical facilities.

The Chairman of the NUC is assigned several tasks as quoted from the Agreement:

"1. Assist the rural electric cooperatives established under this project, or subsequently established, to (a) organize, (b) obtain legal advice, (c) obtain technical, managerial, and other assistance necessary to their development.

"2. Request the Director of Forestry to issue all licenses and permits on a timely basis for the extraction and transport of suitable logs for treatment at the PTP in order to permit the PTP to function at capacity.

"3. Serve as custodian of the RECF which will be deposited in a bank account designated by NUC and will submit quarterly reports of the financial condition of the RECF to the CCC.

"4. Assist the pilot cooperatives to obtain electric power as needed.

"5. Assist the pilot cooperatives in establishing adequate power rates.

"6. Prepare and sponsor legislation or decree to establish with the GVN a standards and lending agency similar to and/or modeled after the Rural Electric Administration (REA) in the US.

"The NUC Chairman will act as the interim GVN Project Manager until the required legislation or decree is adopted to form an REA within the GVN."

The Chairman of the Board of VPC has agreed to make power available to the cooperatives as needed.

The Cooperative Coordinating Committee (CCC) of five members is established to promote and coordinate the activities of all rural electric

cooperatives and to guide and assist the further development of such cooperatives. The committee members include representatives from the Ministry of Public Works (Chairman); the Ministry of Land Reform, Agriculture and Fishery Development (DOC); VPC; NUC; and NUEC. This committee acts as the principal reviewing agency for loans from RECF and assists in resolving any problems which might arise under the Agreement.

The NUEC, as the voluntary national services organization for electric cooperatives, agreed to:

"1. Continue to provide services in support of the activities of the member cooperatives.

"2. Continue to operate the PTP to provide treated poles, first to its member cooperative and later to other users with priority to VPC, Directorate of Posts and Telecommunications (PT&T), and ARVN Signal Corps . . .

"3. Maintain PTP production at a level adequate to generate sufficient income to meet all operation and maintenance cost of the PTP and to comply with the repayment schedule for the physical plant.

"4. Provide quarterly reports of NUEC's financial condition in a form satisfactory to the CCC, and cooperate fully with requests by USAID or GVN for financial statements and with USAID and GVN audits.

"5. Promptly report to the Chairman of the CCC any problems in carrying out its responsibilities under this Agreement.

"6. In the event of recurrent problems in the operation, management, or finance of the PTP after three years probationary period starting July 1, 1970, forfeit PTP assets which will be reassigned by the NUC to another operator as recommended by the CCC.

"7. Have concluded a loan agreement prior to execution of this Agreement, for payment of the capitalized assets of the PTP. Following execution of this loan agreement, NUEC will take title to the PTP."

The General Manager of the NUEC, on behalf of the Board of Directors of each of the three Rural Electric Cooperatives established under the pilot phase of the project, agreed to:

"1. Provide centrally-generated electricity to their present and future members.

"2. Prior to execution of the Agreement and with due delegation of authority by the boards of directors of the three Rural Electric Cooperatives, is able to conclude the loan agreements covering the capitalized assets of their individual cooperatives establishing their obligations to make repayments to the RECF. Thereafter, take title to cooperative facilities, operate them, and account for their operations to the members.

"3. Promptly report to CCC significant problems encountered and submit annual reports of each cooperative's financial condition to NUC."

It is apparent that the policy of GVN is to assist in the establishing and development of rural electric cooperatives with power provided from the central system of VPC.

It is apparent under present GVN policy that there are to be rural electric cooperatives in addition to the existing three pilot cooperatives, and that they are to receive the assistance and encouragement of GVN in their development and operation.

As pointed out in the MAT report the ". . . real economies of electric power are available in the larger more efficient units . . ." and it will be to the benefit of the cooperatives to have access to this power when it is economically justified to connect the cooperative distribution system into the VPC system.

Under the Agreement, VPC agrees to "Make power available to the Cooperatives as needed." This is a wise provision. If VPC central system service is not available, VPC should provide an isolated power unit and operate and maintain it as a power source to the cooperatives. If a cooperative should finance a generating unit, it should be provided that VPC will purchase the unit or units when VPC is in a position to give satisfactory central system electric service.

In order to assure that the cooperatives will have the benefit of the lowest cost power available, NUC should be required to make a study and determination and if it finds that connection of the cooperatives' distribution systems to the VPC central system will provide more economical power, it should issue an order to that effect. Such determination and finding should be made upon application by a cooperative or group of cooperatives, by VPC, or upon the commission's own motion.

Inasmuch as there are many hamlets adjacent to province centers that can be served economically by extensions from the distribution systems in the centers, it has been assumed that 30 percent of the projected rural expansion can be served by VPC and the balance by cooperatives as organized under the Agreement.

The estimated cost of construction for this 30 percent of projected expansion has been included in the fund requirements of this report. The costs

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for the balance of the rural program, estimated at US$91 million, are not included as the funds for this work are expected to be provided by GVN in accordance with the Agreement.

As rural cooperatives are formed, they will be requesting wholesale power from VPC. The majority of the wholesale delivery points will be near province centers. The proposed transmission and subtransmission systems include the projected load for the rural areas as the load forecast includes rural as well as urban areas.

Some of the rural cooperatives may be formed before the bulk power transmission system is completed. In these cases, VPC can serve them by utilizing diesel-driven generators released from service from centers served from the bulk power grid. Other sources of engine-driven generators will be the industrial and commercial establishments that will be using central station power when it becomes available.

VPC design engineers should establish an early liaison with the engineers for the rural cooperatives so that the design of the distribution systems in the centers will be adequate to serve the rural electric cooperatives as well as the fringe rural areas to be served by VPC. This work is simplified in that both VPC and the cooperatives have standardized on 8.7/15–kV for the distribution voltage.

Basically, the method of serving a rural area is the same for each province – a central supply point and radial lines from this point. The variations will come from the location of the power supply point in relation to the service areas. This will determine the number and size of feeder lines. The type of consumer and the type of equipment or appliance will also affect system design.

An example of an area and one possible method of locating electric distribution lines for development of area service is shown on Figure VI–21.

Estimating Costs

Bulk power transmission costs are based on single and double circuit steel tower construction. The double circuit design was assumed in those instances when necessity for a second parallel circuit within a short period was evident. Conductor on all 230–kV circuits was assumed to be 1275 M.cmil ACSR. Basic per kilometer costs used for long span rural construction were the following: For single circuit tower line US$35 500; for double circuit towers two circuits installed US$62 200; and for double circuit towers one circuit installed US$55 000. Short span double circuit construction in the Saigon loop was priced at US$96 000 per kilometer. All prices include estimated rights-of-way, design, engineering, and construction supervision costs. Increments were added to these costs when access appeared difficult and where swampy conditions or mountainous terrain must be traversed.

Subtransmission lines in the Saigon metropolitan area at 66 kV are largely within the built-up areas where rights-of-way will be difficult and expensive and where guying of angles is expected to be impractical in many instances. These circuits are proposed to be wood pole construction except for anticipated use of two heavy self-supporting steel poles per kilometer for turning angles. Conductors are assumed to be 1033 M.cmil aluminum on horizontal post insulators. The estimated cost of US$49 000 per kilometer includes allowances for rights-of-way, damages, design, engineering, and construction supervision.

Provincial subtransmission circuits and those on the perimeter of the Saigon metropolitan area are proposed to be 138–kV single-pole horizontal post or "H" frame long span construction. Wood poles are assumed to be used with 636 M.cmil ACSR conductor. Angles are expected to be guyed in the conventional manner. No accommodation has been made, in general, for underbuilt distribution circuits on these lines because of the long rural expanses between the centers. Estimated cost of US$15 800 per kilometer was used for this construction.

Distribution costs in Saigon metropolitan area were estimated at US$160 per kilowatt of increased demand. This figure has been used by VPC in preparing their budget forecast of distribution expenditures for the period 1972–76.

Saigon metropolitan area distribution substations are proposed to be 30 MVA four-feeder modules similar to those proposed by the consultant for the Saigon–Cholon transmission and distribution programs. Estimated cost for 66/15–kV initial installation in land class "A" (high value) areas is approximately US$546 000. In land class "B" (lesser value) areas, it is US$443 500. Similarly 138/15–kV initial installations are estimated at US$650 000 in class "A" and US$525 000 in class "B" land situations. Additional 30–MVA modules in existing substations at 66–kV are estimated to cost approximately US$395 000 and for 138–kV, US$470 000. Costs include engineering and

construction supervision.

Substations in the outlying provincial centers are proposed to be 138/15–kV with two feeder breakers on each 6–MVA unit and four on each of the larger units. On initial units, power fuses are proposed for high side protection. These will be replaced with breakers at a later time when a second unit is installed. Estimated costs for initial installation are: 6 MVA, US$261 000; 12 MVA, US$403 000; 20 MVA, US$429 000; and 25 MVA, US$459 000. Addition of a second unit with high side breakers is estimated to cost US$360 000; US$425 000; US$451 000; and US$475 000, respectively.

Switch bays were estimated at US$280 000 for 230–kV, US$110 000 for 138–kV, and US$66 000 for 66–kV installations.

Large power transformers were priced at US$15 per kilovoltampere.

The cost estimates for the construction of distribution lines in the area outside of the Saigon metropolitan area were divided into two parts. The first part covered the expansion of the distribution system in the province chief towns to provide service for the pent-up load as well as the normal load growth due to the increase in populations. The second part covered the construction of lines into the rural area to provide service to the hamlets and villages.

Province Chief Towns

The estimated construction costs were based on the material and labor costs and statistical data furnished by VPC. For the province chief towns, an estimated cost of US$5150 per kilometer was used for the line costs. To this was added transformer costs based on the increased demand during the year and the meter costs as meters will have to be furnished as the lines are constructed. The present distribution system is inadequate to serve the existing loads as evidenced by low voltage conditions. Steps have been taken to improve the system but with the heavy proposed additions further improvements will be required. The amount of replacement or improvement can be considered as a function of the new load. The greater the new load, the greater the strengthening of the existing system. Twenty percent of the estimated construction cost for the new load was used to provide funds to strengthen or replace the portions of the existing system feeding the new loads. These funds will be used to increase conductor size and transformer capacity as well as pole changeouts.

Rural

The estimated costs for the line extensions into the rural areas were also based on material and labor costs and statistical data furnished by VPC. In considering the proposed line extensions, it was assumed that for each kilometer of primary and secondary line there would be 0.4 km of trunk line required for the period 1972 through 1979 and 0.5 km of trunk line for the period 1980 to 1986. The longer trunk lines will be required as the lines extend to areas further from the urban or more densely settled areas. Average estimated costs of US$3 270 per kilometer of secondary line only, US$4 400 per kilometer of primary line with secondary (average for three-phase and single-phase primary), and US$4 470 per kilometer for trunk line were used. To this was added transformer costs based on the increased demand and meter costs.

In this report it is assumed that 30 percent of the forecasted rural expansion can be served directly from province centers or chief towns by short extensions. The estimated construction cost for province expansion provide for service to this 30 percent. The balance will be served in accordance with the USAID Agreement.

The present practice of VPC is to charge the customer for the service drop and service entrance cable. Where buildings are too low to provide adequate road clearance for the service, and a secondary line is needed across the street and parallel to the primary-secondary line the customers are required to pay for this secondary line. The estimated cost used in the distribution system costs do not provide for any change in these practices.

Long–Range Distribution Development

A long range distribution plan for VPC or any power company must be directed toward the goal of delivery of energy in a safe, reliable, and economical manner from the subtransmission system to the ultimate consumers.

In consideration of probable rapid increases in saturation of household electrical appliances particularly in air conditioning and television sets, it is important to be aware not only of the increased burdens imposed on the system but, in addition, to recognize the householders magnified dependence upon an adequate power supply. Saturation levels of the two utilization devices mentioned are estimated from information supplied by VPC to be 3 and 35 percent, respectively, at present. Popularity of television is evidenced by the already substantial numbers in

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use. Soon, most customers will have in their homes this device which is capable not only of providing entertainment but of graphically reflecting the quality of electrical service supplied by the utility.

It can be anticipated in Vietnam, as has been the case in the US, that along with increased usage and greater dependence of households upon good electrical service that there will develop a much less tolerant attitude on the part of customers toward interruptions or unsatisfactory voltage conditions. VPC will be obliged constantly to upgrade service quality to meet increasingly critical standards imposed by an ever-more aware public. VPC must build boldly, keeping in mind that seldom has an electric utility system been overbuilt. VPC's load growth in fair measure will be related to the quality and reliability of the service which they are able to provide.

An eightfold increase in the Saigon metropolitan area loads as anticipated by year 1986 means essentially that the capability of the distribution system must increase in similar proportion. The present system represents only a rather small increment in facilities and investment of the system which will be required to meet the needs of the 1980's and later. Today's system, then, should not necessarily dictate perpetuation in kind, particularly if it has been found to have distinct disadvantages.

The present system of underground primary cables, cabine housing of large transformers, and long runs of small secondaries, expensive and inadequate in many instances for present loads, will just not do the job in meeting the demands of tomorrow. Expansion of this massive, inflexible system with more cabines at closer and closer intervals to satisfy new and growing loads is inconceivable, cost-wise and space-wise.

VPC has already recognized that less expensive, less complicated construction must be utilized if their program to overtake the pent-up demand and keep abreast of current needs through maintenance of adequate distribution systems is to be successful. It has been determined to use overhead construction wherever possible in their expansion program, utilizing wood poles and pole-mounted transformers. Overhead primary construction has been found possible and is presently being expanded and although street trees and other obstacles are found numerous, they are not insurmountable. Insulated aerial cable or underground sections have been anticipated in those instances where open wire for primary may pose a safety problem or otherwise be unsatisfactory.

Certain parts of the central city may, at some future time, require underground network service depending upon load density and the type of loads to be served. These situations will require detailed study and coordination with city planning and with other utilities occupying subsurface space in street and sidewalk areas. It should be kept in mind that while the street network installation affords highly reliable service to areas of heavy densities which are aggregations of moderate increments, it is also the most expensive system. Presumably, network would be at 220/380 volts. In the event high-rise buildings with large individual demands are constructed in the downtown areas, service from spot networks fed by the 15–kV cable system should be considered. Vaults for such service might be provided within the buildings or in adjacent subsidewalk space, if available.

Fortunately, the voltage level of 15–kV has been in use by VPC and is quite suitable for continuation as the standard for primary in the metropolitan area. The recommendation to "wye" this system as proposed by Sanderson & Porter is endorsed and can effect substantial savings particularly in serving new areas if the accompanying recommendation to limit the granting of three-phase services to motors of 7.5 hp or larger can be implemented.

The long-range plan to assure adequacy of the distribution system involves construction of new substations and feeders so located and at a rate to keep pace with load growth. Foregoing sections have advised the extent of the anticipated construction programs including an estimate of annual additions. An approximation has also been made as to locations of the distribution substations expected to be required in the long-range program.

It is not possible, within the time alloted for this study, to detail a complete master plan for development of the distribution system. This, however, is suggested as a project to be undertaken by VPC to produce a guide which will serve to orient the day-to-day engineering and construction toward accomplishment of the ultimate plan. It is suggested that this master plan attempt to look forward ten years or more and that it designate substation locations and the main feeder routes to be developed. Information of this nature may best be shown on a map which would be utilized as a guide by every

engineer or technician who is responsible for any additions or changes in the distribution system. Each work order may then be reviewed in the design stage to see that it is in conformity with the plan and makes an appropriate contribution to its accomplishment. Such a master plan must remain flexible and will require updating periodically to reflect changes and a continuing forward look.

In selecting a substation site, it is important to overall economy and best distribution that a location at or near the load centroid of the area to be served is chosen. This check should be made initially on the basis of the best information available when setting up the master plan. A periodic review is suggested as a follow up, then a final check on this aspect should be made prior to purchasing the site. It will frequently be found advantageous to shift slightly from the theoretically best site to a location at a nearby street intersection to facilitate feeder exits.

Main feeder routes are selected insofar as possible to bisect the load area to be served by the facility. This results in a symmetrical design and limiting branch circuit lengths to each side of the main. An important consideration, and one which may alter this criterion, is that the feeder main be clear of hazards to the greatest extent possible. Overhanging trees represent a considerable threat to continuity of service on overhead lines during storms and are to be avoided wherever possible in the main stem route. Judicious trimming or removal, in some cases, will be the answer. Each feeder for switching and emergency operation will ultimately require at least one remote tie to a feeder from another source. It is also suggested that in lieu of a switching arrangement internal to the substation, consideration be given to a less expensive external tie through a gang-operated air break switch to an adjacent feeder from the same substation at or near the cable pole. These ties are most beneficial if made between feeders from opposite transformers thus serving to back up not only loss of a cable but, the more rare event, loss of a substation transformer. A complete field check is required to assure that the route selected for each feeder main is feasible and that it can be made free of undue hazards to service continuity.

A nominal rating of 7.5 MVA for the new 15–kV feeders as has been suggested by Sanderson & Porter is reasonable and compatible with the proposed 30–MVA transformers. Each transformer would then supply four feeders. It is recommended, however, that these feeders be capable of handling loads of 12–14 MVA to accommodate normal inability to maintain balanced loading between feeders and to provide capacity for emergency switching. Conductor sizing, particularly in the feeder mains, should be studied in relation to the economic aspects relating to cost of losses. It is usually the case that a much larger conductor than is normally required by thermal and voltage drop limitations can be justified when capacity and energy costs of losses are evaluated.

Consideration is being given to the use of sectionalizers, reclosers, and fuses for isolating faults in the 15–kV feeders. These devices are effective and perform well when properly coordinated and maintained. It is suggested, however, that for the early years at least, a less sophisticated system utilizing a substation breaker or recloser and fuse combination be evaluated. In this system, the feeder main might be sectionalized into approximate thirds, load-wise, with ganged, manually operated air-break switches. All branches off the main which could be fused load-wise would be fused. Major branches which could not be fused at the main may be fused as subbranches at the first logical point. Branch line fuses would be one size only, the largest of which could be coordinated with the substation breaker. No series arrangement of branch fuses is suggested other than the fuses at the transformer or capacitor location.

Branch line fuse loading may be satisfactorily monitored and also phase balance controlled by maintaining engineering phase map records and loading data. Work orders would specify phase connections for all primary work including transformer additions or changes.

It is recommended that capacitor installations be utilized on the new feeders in a manner not only to supply so far as possible the reactive requirement near the loads but to assist in maintenance of proper voltage levels. A combination of fixed and switched primary capacitors is suggested for application on each feeder so that the power factor on the substation 15–kV buses at peak load is near unity while off-peak feeder voltages are maintained within satisfactory limits. Capacity installations should be in large blocks for economy reasons limited, however, by the maximum tolerable voltage swings resulting from operations of switched banks. An annual program of capacitor additions in a ratio related to the increased system load is recommended. As the interconnected system develops to include centers in the provinces, these

too should receive the same consideration in regard to local var supply and associated voltage regulation by proper application of capacitors.

Distribution transformer installations which are made in consideration of probable load development are the most satisfactory. It is uneconomical to add or install this capacity in too small increments. A transformer should be installed of a size which will permit handling anticipated load growth for eight to ten years without replacement. Following this practice will permit elimination of several intermediate transformer sizes and reduce inventory and stocking problems.

Nominal secondary lengths are propsed to be established as outlined by the consultants. Sufficient flexibility in design is suggested to permit later reinforcement by installing intermediate transformers while still maintaining supply in two directions from the new units. A substantial secondary size is suggested, preferably in triplex or quadruplex for all new or replacement work. This type installation offers advantages in ease of installation and appearance and, with lowered reactance, reduces flicker problems from motors starts.

In order to eliminate the practices of a metered customer supplying power to subcustomers and the outright theft of current by unmetered taps, an aggressive program is required. First, a definite procedure on the part of VPC is required to have the subletting of power by a customer forbidden as a condition of furnishing service. Secondly and coincident with the above, it will be necessary for VPC to be in a position to furnish direct service to all customers.

It is believed that the authority necessary to forbid subletting of power should be specifically conferred upon VPC by GVN, perhaps as a provision in a new franchise agreement. A proposed new franchise now being reviewed has, under General Provisions, Article 6, Paragraph A, this wording: "The subscriber shall not let part of or whole power to anyone else." Assuming this proposed franchise is executed, sufficient authority should then be in VPC to control the problem. It is understood that legal recourse is presently available to VPC in the case of policing unmetered taps and that the initiative lies with VPC.

Providing direct service to all eligible subscribers involves many difficult situations. Houses with protruding balconies located in the interior of blocks and along narrow alleys or passageways are so close in some locations that normal open wire lines cannot be safely installed. Tree conditions are heavy and varied making both installation and operation of normal construction difficult in many instances.

The use of the suggested triplexed or quadruplexed secondaries and service loops will assist in some instances. When it becomes necessary to introduce primary wires with transformers to reinforce the longer secondary runs, it is recommended that fully insulated aerial cable be considered where clearances are inadequate for open primary. There are situations where attachments to buildings offer a solution and, in other cases, underground installation with direct buried cable and pad-mounted transformers will be the only logical treatment. Each case will require separate investigation and appropriate construction.

Looking to long-range improvement, the adoption and enforcement by governmental authorities of building codes covering new construction which would include restrictions of overhang into public rights-of-way and also require minimum setback of buildings from side and rear lot lines are recommended. The clear lanes thus reserved would insure not only ready utility access but would improve fire safety. In addition, consideration might be given to a policy change wherein VPC would finance the cost of service loops and remove this initial burden from the prospective customer as an inducement to his seeking direct service from the power company rather than from an adjacent household.

It is important at the outset for the development program visualized in this study that comprehensive construction standards be developed and adhered to, particularly in the distribution system where there is a very large volume of repetitive operations. A good set of standards will require some effort to establish but the benefit is inestimable in time saved for engineering and construction forces. The uniformity of construction resulting will simplify operation and maintenance functions and contribute to overall improved appearance of the system. An approved materials listing and detailed specifications established in conjunction with the standards will assist purchasing and alleviate problems of stocking a multiplicity of items which serve a common purpose.

Transmission and Distribution Beyond 1986

Electrical loads will continue to grow in Vietnam as they do elsewhere in the world and additional sources of generation will be provided.

Justification for larger and larger units of generation goes along with system growth. When the more accessible in-country hydro resources are exhausted, it will be necessary to look to larger thermal plants, nuclear sources, or to remote hydro in country and across national boundaries.

By 1990, it is anticipated that additional power from Yali Falls and the Upper Se San resources could be used to meet loads in the Saigon area. A large scale development at this distance (in excess of 400 km) from point of delivery is expected to require EHV transmission. The next logical step above existing 238–kV bulk power transmission might be 500 kV.

Large scale nuclear generating plants along coastal areas might also be considered, for example, at Cam Ranh where heavy industrial loads are considered possible. It would be desirable to tie such large sources into an overlay of (extra high voltage) EHV lines which would reinforce the present 230–kV system at strategic points.

Within practical transmission distance, are the tremendous hydro reserves represented by the Mekong and its tributaries in Cambodia, Laos, Thailand, and Vietnam. VPC should consider the opportunities and advantages to be gained by interconnections with a system of the size proposed for this development. Represented in the opportunity to become part of such a system are advantages in availability of large additional blocks of low cost energy, improved diversity, strong back up to override sudden loss of a large unit, diversity of catchment basins, reduced spinning reserve requirements, backup for routine maintenance operation, pooling of resources, reserve for contingencies occasioned by natural or other disasters, and scheduling of generation for best overall efficiency.

It is conceivable that with the proposed Sambor hydro, which is part of the overall Mekong project and located just 230 km northwest of Saigon, an EHV line might, at a future time, be looped through Saigon then proceed northerly to Upper Se San sites and back to other Mekong stations in Laos. This is a long look ahead, perhaps 25 to 30 years, but loads by that time, assuming even moderate rates of growth, will have exhausted economical in-country hydro resources and other solutions must be sought.

The Mekong development should be watched closely as part of overall system planning. Voltages already considered in the studies of this development extend to 765 kV and could exceed this level as the art develops. VPC may desire to utilize, as part of an intertie, certain parts of the VPC system designed to accommodate input at the ultimate voltage selected by the Mekong group.

Financial requirements for construction of the generation, transmission, and distribution facilities for the three Plans A, B, and C are summarized on a year-by-year basis in the Tables VI–24 through VI–30 which follow. Not included in these tables are costs of certain projects on which financing has already been obtained or is being negotiated elsewhere, such as the Can Tho first stage steam plant and subtransmission project, installation of 96 MW in heavy oil diesels in Saigon, installation of 30 MW in small diesel units in the provinces and rural areas, and the first stage of transmission and distribution reinforcement related to the Thu Duc thermal units now being installed. It should also be noted that only the VPC portion of rural expansion, 30 percent of the estimated total, is included in the tables. References to expenditures in the following paragraph are to those unfinanced requirements as used in the tables.

Plan A, the recommended plan, cost-wise is in an intermediate position. This plan requires a total expenditure over the fifteen year period by VPC of US $1277 million for generation and transmission and distribution development. In addition, for 70 percent rural work, GVN would need to provide US$91 million. Foreign exchange in the amount of US$895 million represents about 70 percent of the total for VPC and local costs amount to about 30 percent or US$382 million. Plan A, overall, requires an investment of approximately 16 percent, or US$180 million, more than Plan B and approximately 8 percent, or US$108 million, less than Plan C.

Annual expenditures for construction under Plan B beginning in year 1972 and through year 1983 are lower in each instance than for Plan A. Plan B requires overall funds by VPC of US $1096 million for the development program. Of this figure, US$773 million, or about 70 percent, will be in foreign currency and US$323 million, or 30 percent, local expenditures. In addition, GVN would have to provide US$76 million for its 70 percent share of the rural work.

Plan C involves total expenditures by VPC for construction in the amount of US$1385 million over the 15-year period. Foreign exchange is US$973 million, or 70 percent, and local costs, US$412 million, equivalent to 30 percent of the

gross amount. Plan C involves US$40 million (11 percent) greater expenditure in the first five years than does Plan A. In addition, GVN would have to provide US$91 million for its 70 percent share of the rural work.

Foreign and in-country expenditure ratios were estimated for hydro at 65 percent and 35 percent, respectively; for thermal, 80 percent and 20 percent; and for transmission and distribution, 70 percent and 30 percent. Expenditures are based on 1971 estimated costs and constant 1971 dollars.

MANPOWER REQUIREMENTS

The estimated manpower needed in Vietnam for the construction effort shown for Plan A is shown on the following table.

Plan A
Number of Men Needed by Years for Construction Program

Years	Hydro	Thermal	T&D*	Total
1972	600	800	300	1 700
1973	2 400	1 000	500	3 900
1974	4 800	1 000	500	6 300
1975	7 600	700	500	8 800
1976	7 400	700	600	8 700
1977	10 000	500	400	10 900
1978	7 900	1 500	400	9 800
1979	6 400	1 800	400	8 600
1980	5 000	1 700	400	7 100
1981	2 800	1 500	500	4 800
1982	5 900	1 400	600	7 900
1983	6 300	1 300	600	8 200
1984	4 700	1 800	500	7 000
1985	8 700	1 800	500	11 000
1986	6 400	1 800	500	8 700
Category				
Civil Work	90%	35%	40%	
Mech Work	5%	55%	minor	
Elec Work	5%	10%	60%	

**Does not include 492 electrical construction men on VPC payroll in 1971.*

Somewhat more would be needed under Plan C and less for Plan B during the 15-year period. These are in addition to the VPC permanent staff consisting of 492 persons (1971) engaged in transmission and distribution construction. It is anticipated that most of the additional work in transmission and distribution will be contracted out as well as all the hydroelectric and thermal plant design and construction.

The method of calculating manpower needs was to examine the relationship of the number of workers at a given period in the construction of representative hydro, thermal, transmission, and distribution projects to the amount of construction funds being expended during the period. The ratio of dollars of construction funds expended per worker was used in conjunction with the construction cash flow in the indicated years to determine the estimated total number of workers per year.

At the present time, the availability of men to VPC is not very high. The military services take all the able-bodied men between 17 and 38 years of age which greatly reduces the selection. Also, VPC does not pay wages which are competitive with contractor scales. Unless there is wide unemployment, VPC will continue to have difficulty unless it revises its pay scales to be more competitive.

If most of the US troops are withdrawn in 1972, which now seems likely, MACV estimates that upwards of 20 000 skilled Vietnamese construction workers will become available. Most of these people are skilled in so-called "horizontal construction" having been employed mainly on roads, airfields, bridges, canals, dredging, etc. They will be suitable for use on dams and power plants. Those employed on local electrical distribution systems and maintenance needs of the military-connected construction will provide trained people in these fields. These, together with a relatively small number of out-of-country experts and staff personnel, should make it possible to handle the VPC construction manpower needs. It is recognized that there will be other construction requirements, particularly for industrial facilities, but a large number for use as a cadre and for training others would seem to be available.

From 1961 to 1964, a Japanese firm constructed the Da Nhim hydroelectric plant southwest of Dalat. It reported using 440 Japanese experts and staff people and 3700 Vietnamese "laborers" at peak employment. No breakdown is available as to the 3700 laborers but it must be presumed that many were skilled or became so since the US$47.6 million (1964 prices) project was well constructed and on time including the dam, power house, 230-kV transmission line from Da Nhim to Saigon, and the Saigon Substation.

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The present construction work for the building of the two 66–MW unit fuel electric plant at Thu Duc employs mainly Vietnamese labor in all categories. Out of a total of about 500 workers, less than 20 are from outside Vietnam. The USAID Audit Report No. 9–730–72–1, dated July 13, 1971 has this very interesting statement:

"An unexpected by-product of the contractor's performance deserves mention. Prior to and during the negotiation cycle, the labor market in Vietnam changed radically. The military draft has virtually exhausted the supply of skilled and unskilled labor. As a result, the contractor's work force consists of women, disabled veterans, and young boys in their early and middle teens". The contractor " . . . turned this raw work force into an effective team of construction workers. The welders, mill-wrights, and other craftsmen trained . . . will be of immeasurable value to the Vietnamese economy."

It is believed that VPC construction manpower requirements can be met as needed particularly if the work is done under contract.

The expansion of the Vietnam power system will necessitiate the development of an ever-increasing organization of trained personnel to operate and maintain the various power plants, transmission lines, substations, and distribution facilities. Training programs should be inaugurated and carried on continuously with properly trained and experienced instructors for each specialized function.

It would be well to select people who have had the necessary education and other qualifications for training to become supervisors in the various fields of operation and maintenance. These people should be sent abroad for extended periods of time to actually work with their counterparts in some of the electrical utilities and become familiar with modern techniques and methods. Upon completion of their foreign training, these people would then be available to train others for supervisory positions.

As a means of training power plant operators and maintenance technicians, the customary practice is to assign them to the construction organization while the power plant is being constructed so that they can become familiar with the equipment they will operate when the power plant is completed. This kind of on-the-job training is an excellent way to develop the knowledge and skills that the operating and maintenance personnel should have to properly operate the electrical facilities in an expanding power system.

Specialized training courses should be organized to train personnel in such special fields as relaying protection, etc., which are vital for proper operation of a large interconnected power system.

Similar specialized training should be established to train power system dispatchers.

Communication is another specialized field where training is necessary.

COOPERATIVES, MUNICIPALS, AND ON–SITE GENERATION

Cooperatives

The USAID agreement provides for the continuation and expansion of rural electric cooperatives. This Agreement is discussed in detail earlier in this Section along with the overall rural electrification development.

The cooperatives will be responsible for the design and construction of their rural distribution systems. After the systems are energized, they will be responsible for the full operation and maintenance of the systems. As outlined in the Agreement, the cooperatives may obtain assistance and advice from NUC.

Inasmuch as both VPC and the cooperatives will be serving rural areas, it is necessary that a close liaison be established between the two in order to resolve any question concerning service areas and points of delivery of power as well as to assure that full coverage will be developed.

Municipal Systems

There are no generation or distribution systems of any size that are owned and operated by a village, town, or city. There are cases where a province or a hamlet has purchased or obtained a small engine-driven generating unit to furnish power and energy to a government-owned building or facility and a few consumers when central station power was not available. Service from these units is limited and often on a part-day basis.

VPC is serving or will be serving all of the province centers and cities by the end of 1971 except those being served by SIPEA. It also will be serving many district centers, or subdivisions, of a province.

Population centers will be receiving increased amounts of power as the generation and transmission systems are expanded by VPC.

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On-Site Generation

In the provinces, as well as in Saigon, there are many installations of engine-driven generators owned by individuals or companies. These units serve as prime power where central station power is not available due to insufficient generating capacity in the center or the lack of a central station distribution system. In some cases, they are used to furnish power to part of the owner's equipment where full or additional power cannot be given to the customer because of lack of generating capacity in the system. A third use is for stand-by service to be used when central station power is curtailed or interrupted.

Reports received by VPC from 24 provinces outside of the Saigon metropolitan area show a total of 6104 kW of privately owned generation and 12 667 kW of GVN owned generation. The breakdown of this generation into stand-by, supplemental, or full service equipment was not given.

It can be assumed that, as the generation and transmission system are constructed by VPC, the number of on-site generators will be reduced. Some of the units may be retained as stand-by power for essential equipment or services in case of power interruptions. In order to add the portion of this on-site generation that is potential load to the distribution systems, an equitable, promotional rate must be established.

ASSESSMENT OF FRENCH FRANCHISES

As of August 1, 1971, there is only one French franchise for utility operations in Vietnam. This franchise, registered March 28, 1941, is the one granted to SIPEA. The franchise expires December 31, 1975. At the present time, management, including middle management, is entirely by the French. The franchise provides, by Article 25, that the conceding authority, at its option, may take over the concession prior to December 31, 1975 with appropriate compensation to the concessionaire.

Balance sheets and earning statements of the concessionaire have been examined but no attempt was made to determine present value of the property since such an evaluation would be of little value two and a half years from now. In the meantime, the value of the diesels will decline materially. SIPEA is unable to get foreign exchange for major replacements and it is the intention of VPC to loan equipment as necessary to keep present customers supplied with electricity. The concessionaire is capitalized at f5 177 000 (somewhat over US$1 million) and may eventually be worth more or less depending on capital additions vs. depreciation since 1941.

The property owned by the concessionaire consists only of production facilities, all diesel, and electric distribution systems in seven separate locations. The following information was supplied by NUC.

Location	No. of Customers	Installed kW
Da Nang	6 569	12 500
Nha Trang	6 773	9 500
Hue	6 297	5 000
Thap Cham	3 008	1 500
Hoi An	1 302	1 200
Quang Tri	938	1 000
Dong Hai	256	130
	25 143	30 830

The areas served by the concessionaire are all along the coast as shown on Figure V–4, Section V. At present, they operate as separate units. They will necessarily continue to so operate until a transmission line or lines are built. This should present no problem with respect to takeover since many other provincial locations operated by VPC are presently operated as isolated systems. It is, therefore, entirely practicable to incorporate all such locations into the VPC system.

Article 26 of the franchise provides for the repurchase of the concession prior to expiration by one of two possible options. The second method is not applicable during the last 15 years of the franchise and, therefore, need not be considered. Under the first method (now applicable), the repurchase of the concession calls for an indemnity, in brief, equal to the average net profit of the best five years out of the latest seven years or the net profit for the seventh year, whichever is the larger.

Since, however, VPC has many problems to solve in the immediate future, it is recommended as being most practical and economical that VPC proceed to acquire the concession properties in accordance with Article 25 of the franchise.

However, since SIPEA has dropped its right of franchise in other locations, VPC must be prepared to take over if SIPEA, before the end of the franchise period, fails to give good service or if GVN directs that the properties be taken over.

ENVIRONMENTAL FACTORS

Generating Plants

Environmental considerations have become

increasingly important factors in the location, design, and operation of thermal generating stations as the size of the plants and their outputs have increased. The problems of air pollution and heating of natural water sources should be carefully considered at all future thermal generating stations. The incorporation of proper and adequate measures to minimize pollution is becoming a matter of public concern. These problems are being recognized by the electric power industry and large sums are being spent for research and control of air pollution.

The objectionable thermal, particulate, and gaseous emissions from thermal power plants have been identified and measured. Their magnitude can be predicted for any given combination of fuel and operating conditions.

Water used for cooling purposes in the power condensers and discharged into natural streams or lakes raises the temperature of the water. The increased temperature of the water has, in some instances, been beneficial to aquatic life and, in some cases, perhaps harmful. Careful investigation should be made to determine what the situation may be. In sites located on fresh waters, cooling towers are used, in many cases, to alleviate the situation. The use of water mixing zones and spray ponds may be suitable in some cases depending upon conditions. Where salt or brackish water must be used for cooling, mixing zones or placing the discharge end of effluent conduits well offshore is a possible solution. First, however, it should be determined, if at all possible, if the heating of the natural waters will be detrimental since all such devices are expensive.

Air pollution caused by thermal power plants stems from the particulate matter and gases emitted from furnace stacks of fossil fuel burning plants. It is considered to be a problem when the combinations, concentrations, and time-duration of contaminants in the atmosphere are injurious to normal plant life, animal life, or human health, significant damage to property occurs, or nuisance conditions are created. The pollutants of major concern are fly ash and polycyclic hydrocarbons in the particulate group and the oxides of sulfur and nitrogen in the gases. The use of tall stacks can assist greatly in minimizing objectionable air pollution and fallout on the ground.

Fly ash emission is objectionable because it soils exposed surfaces, limits visibility, and is annoying to people. It also may constitute a hazard to health. Most of the fly ash in the furnace stack can be removed from stack gases by mechanical separation or electrostatic precipitators.

The sulfur-derivative gases are usually considered to be the most objectionable pollutants associated with fossil-fuel consumption. Sulfur is present in varying amounts in almost all fossil fuels. Most of the sulfur that is contained in fuels appears in the stack gases as sulfur dioxide. After emission from the stack, the sulfur dioxide may be converted to sulfuric acid depending upon meteorological conditions and, if this occurs, the acid particles in the air create a potential health hazard and are a nuisance and economic problem. Removal of sulfur oxides from flue gases is both difficult and expensive. Use of low sulfur oil will avoid these conditions but it is more expensive than oil with a high sulfur content. A great deal of investigation and research is being devoted to this and other emission problems.

Nitric oxide and nitrogen dioxide are formed in the high temperatures of the combustion chamber. These oxides of nitrogen may, under certain conditions, produce toxic and vegetation-damaging substances.

In heavily populated areas, such as the Saigon metropolitan area, there is a limited tolerance to pollutants because of health and nuisance considerations. Such areas have the disadvantage of high ambient concentration of pollutants from automobiles, motorcycles, trucks, buses, industrial establishments, and other sources. In view of this condition, the location of a site for a future large thermal generating station in the Saigon area should be selected so as to avoid, as much as possible, superimposing the pollutants from the station on an already seriously polluted area. Furthermore, proper steps should be taken to minimize the emission of harmful pollutants from these plants.

Normally hydro plants have no environmental problems. In some cases, the fluctuations of stream flow resulting from large and sudden changes in power plant loading may be objectionable.

Deforestation and denuding of watersheds above hydro projects should be avoided so as to minimize the deposits of sand and silt in storage reservoirs and shortening their useful life. Hydro plants, properly operated, usually tend to improve stream flow conditions, reduce floods, and provide recreational benefits.

Transmission and Distribution

Overhead lines in certain locales represent an

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intrusion upon the environment; in other instances, the structures and catenaries may be considered as representing the only relief in an otherwise drab scene. There is a time and a place in which each of the various types of overhead construction will find its niche and there are also areas in which no design of overhead line is appropriate.

In embarking upon a program of expansion such as that faced by VPC, economy of construction must be a foremost design criterion. Economy and ease of construction are inherent in the overhead systems and, with reasonable attention to preservation of the amenities and characters of neighborhoods, this construction will most likely be acceptable to the public.

Various configurations and designs for pole-top construction have been utilized in the US and elsewhere to improve the appearance of lines. It is suggested that these designs be investigated by VPC as part of their present program to develop new standards for overhead construction. A big step in improving appearance has been accomplished by new designs which replace the old style crossarm with either horizontal post insulators or fiberglas reinforced stand-off brackets for primary construction. Limiting pole lines to a single primary circuit with triplexed or quadruplexed secondaries which serve the dual purposes of providing services to buildings and street illumination is an improvement relatively easy to achieve. Multiplicity of poles, particularly at intersections and along main thoroughfares, creates not only a cluttered appearance but a safety hazard for motorists. In this respect, a joint effort by electric, communications, and city services is indicated to consolidate facilities both for appearance and in the interest of economy.

Color treatment of poles, pole line hardware, and equipment has been relatively successful. The pastel shades of sky-gray, blue, etc., make a less massive appearance than the darker colors and tend to blend with horizons. Certain efforts have also been made in designing the dimensions of pole-top equipment and in mountings to give a slimmer silhouette and thus be less obtrusive. Preference might be given to these.

Attention should be given to spotting locations for poles and guying so as to inconvenience residents to the least degree possible in the matters of access to their properties, maintenance of lawns, and intrusion upon views. Use of self-supporting tubular steel poles offers a solution when conventional guying would be unusually objectionable or, in some instances, setting a wood pole in concrete or well-tamped crushed stone will be sufficient to hold lighter angles and deadends. Locations can be chosen for poles which must carry heavy equipment, such as capacitor banks, to be on more secluded or lesser travelled streets or alleys.

Tower lines must be kept clear of danger trees and heavy undergrowth to protect service continuity and assure access. When these lines run through forested areas, a great deal of timber cutting is necessary; accordingly, when such areas can reasonably be skirted, savings can be realized and the creation of unattractive cutting lanes avoided. Routes in the urban areas for tower lines should be selected to avoid the more heavily built areas while taking advantage of any natural formation as screening. Judicious use of color in tower painting is also helpful in making these structures appear less obtrusive.

These are but a few of many avenues available for making overhead line installations more acceptable. Utilities worldwide have found the appearance of overhead construction to be a matter of serious public concern and, therefore, worthy of attention.

TYPICAL DAILY LOAD CURVES
SAIGON METRO SYSTEM

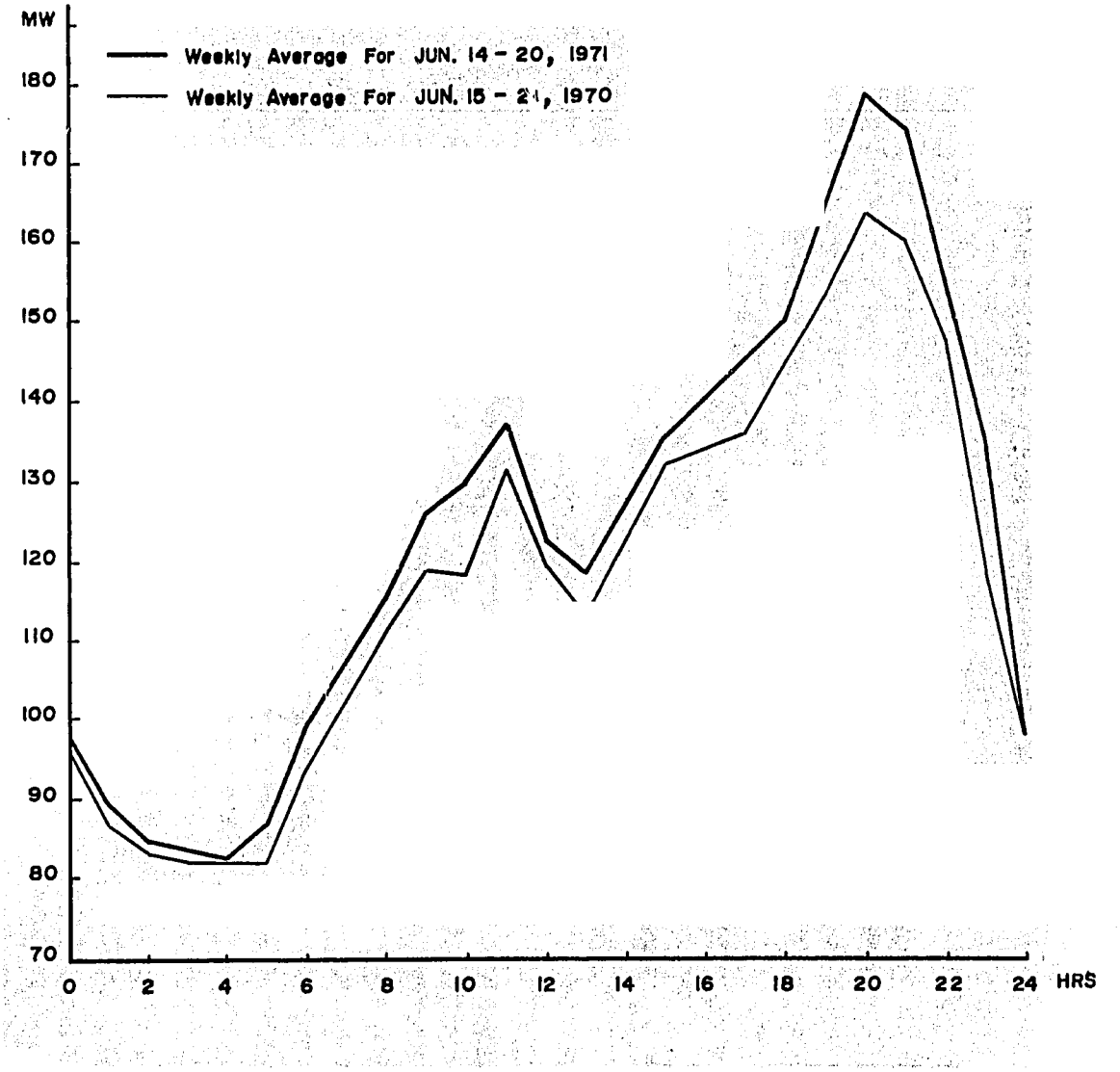
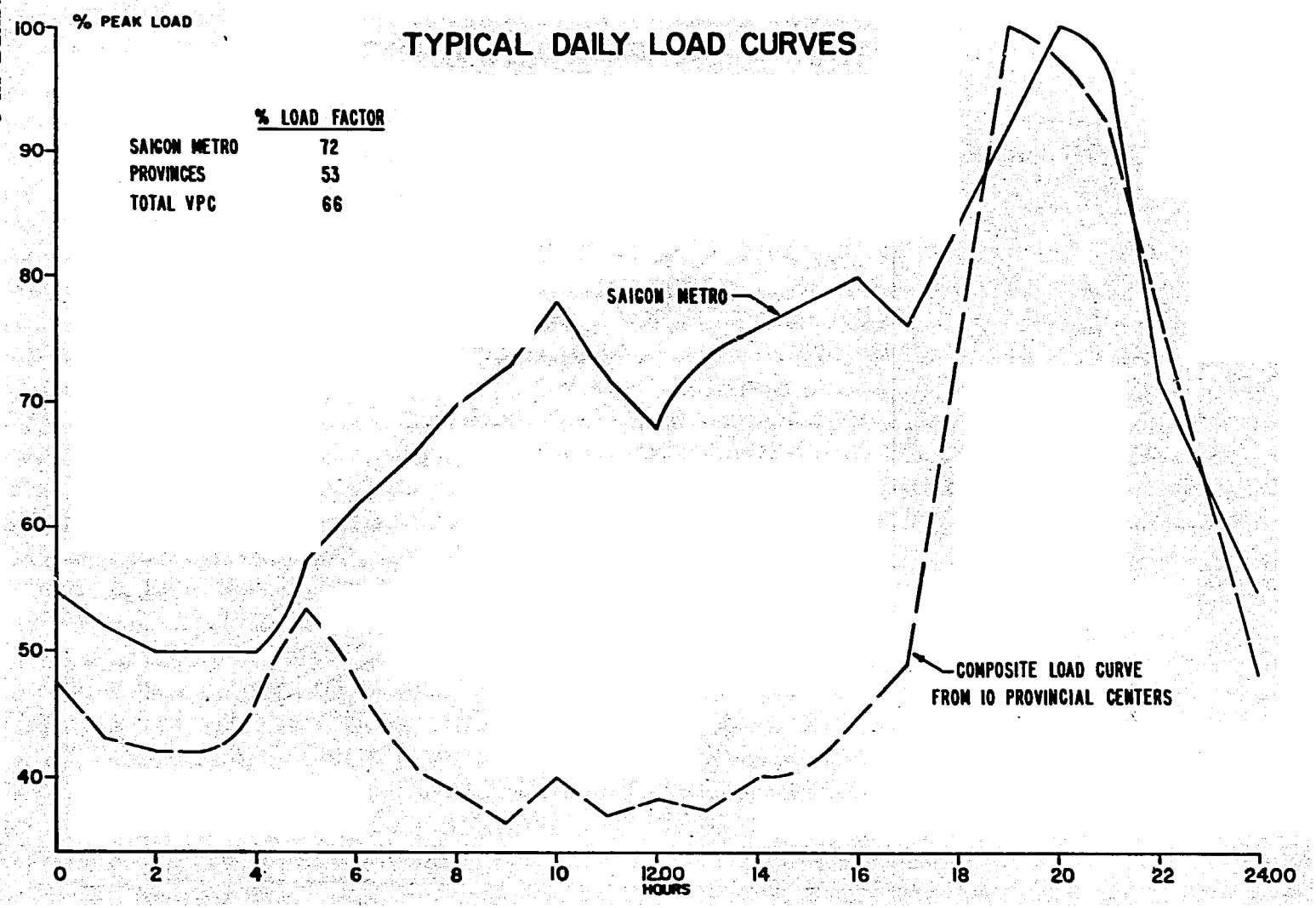


FIGURE VI-1

FIGURE VI-2



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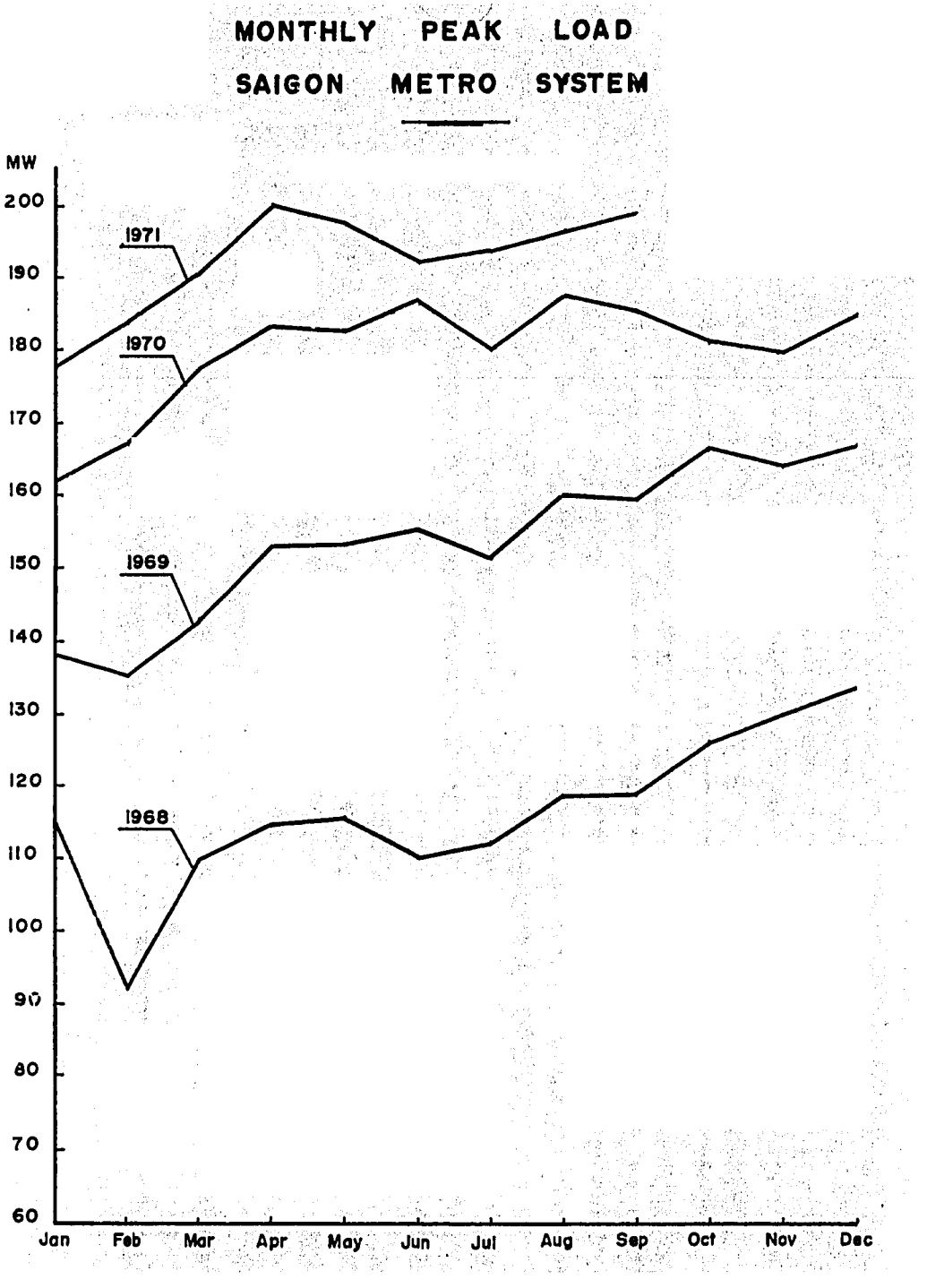

FIGURE VI-3

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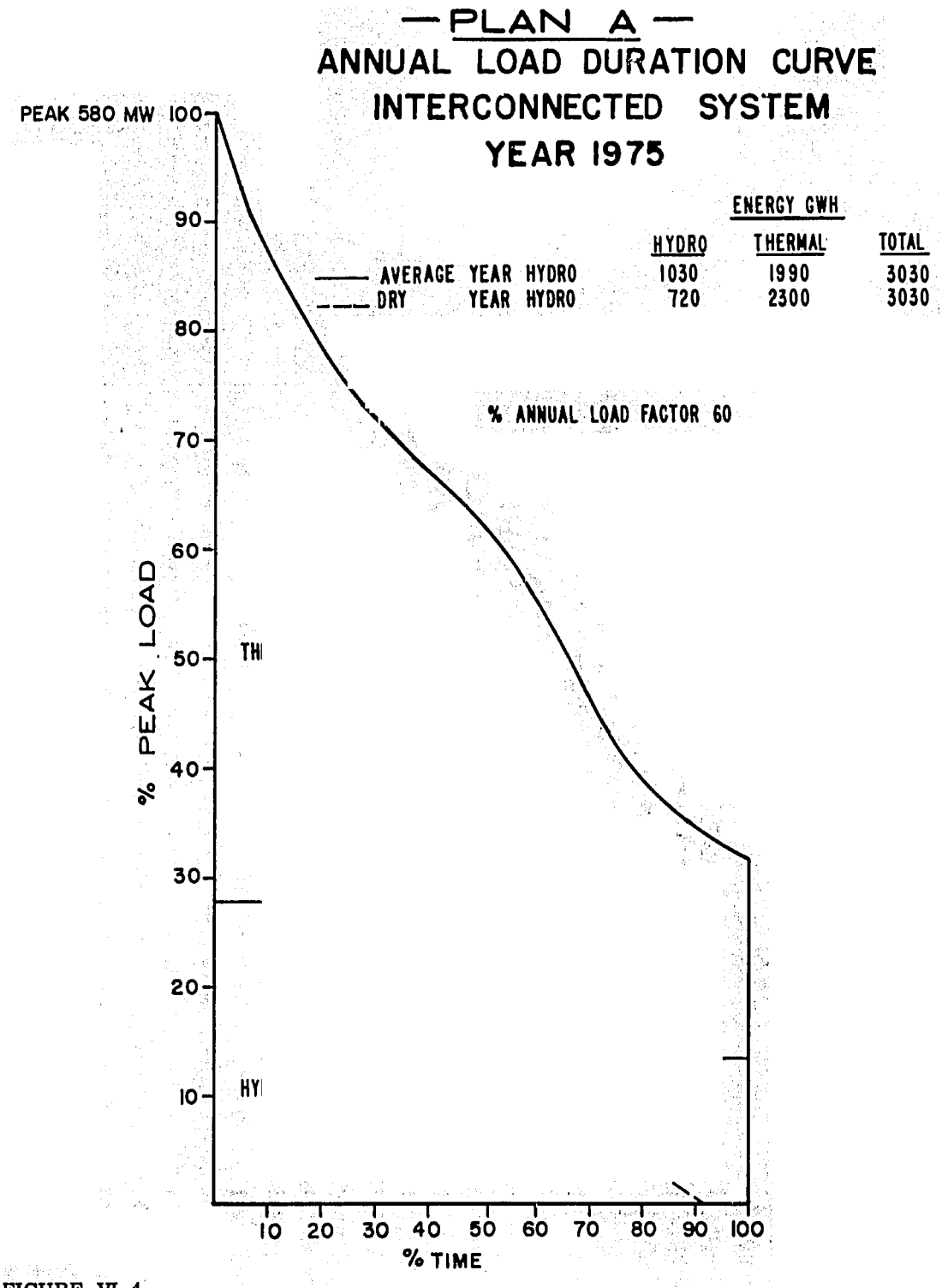

FIGURE VI-4

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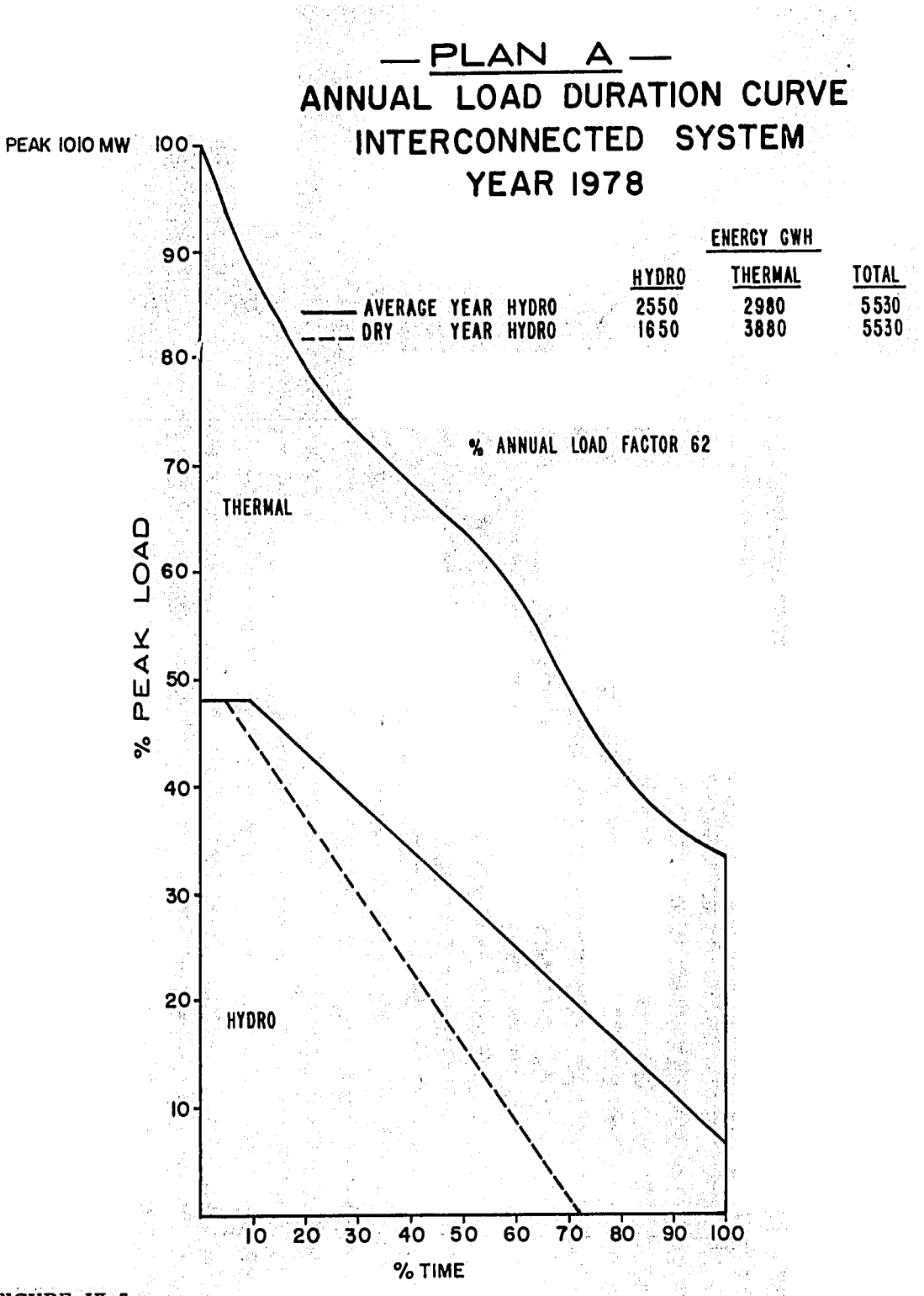

FIGURE VI-5

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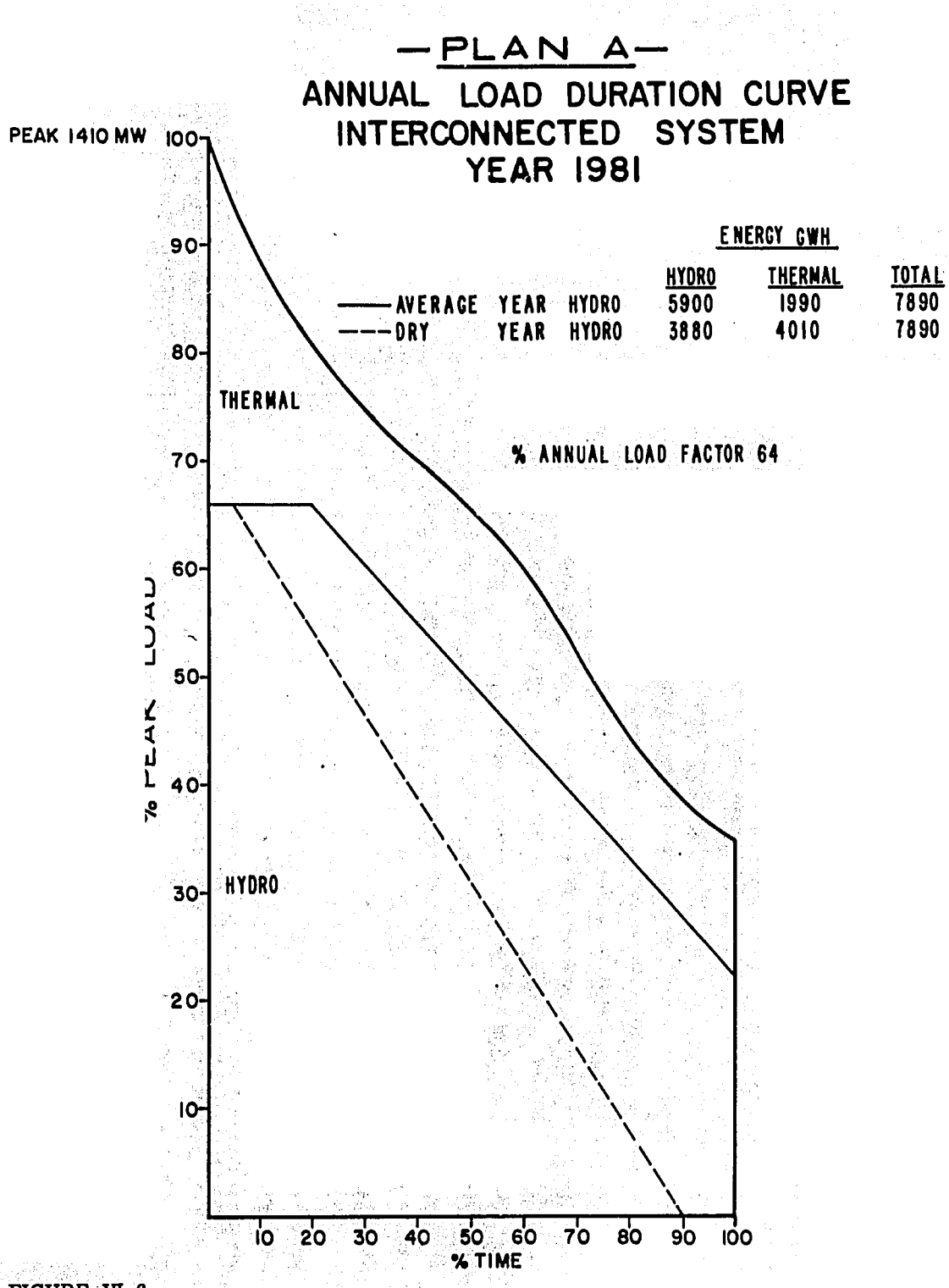

FIGURE VI-6

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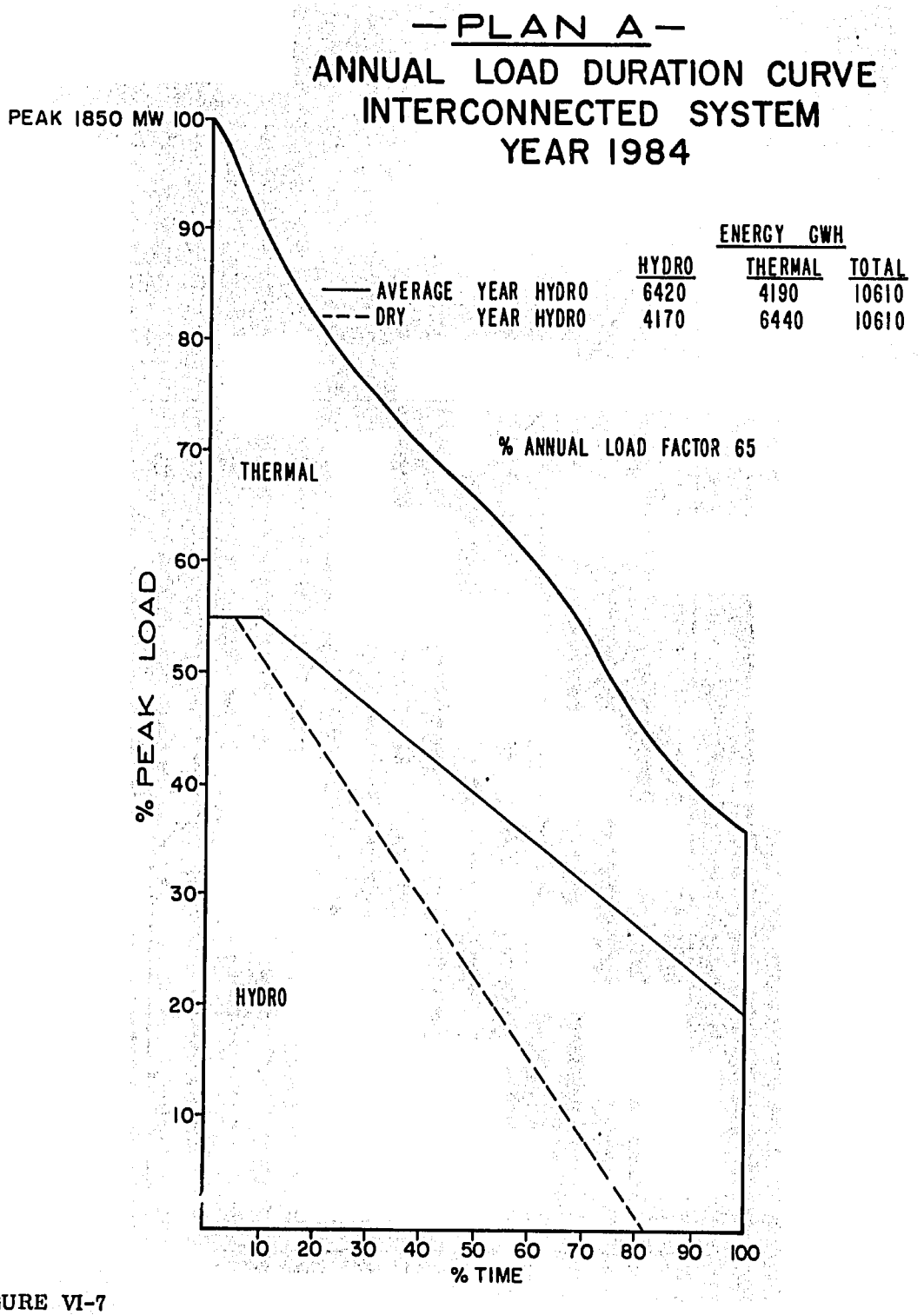

FIGURE VI-7

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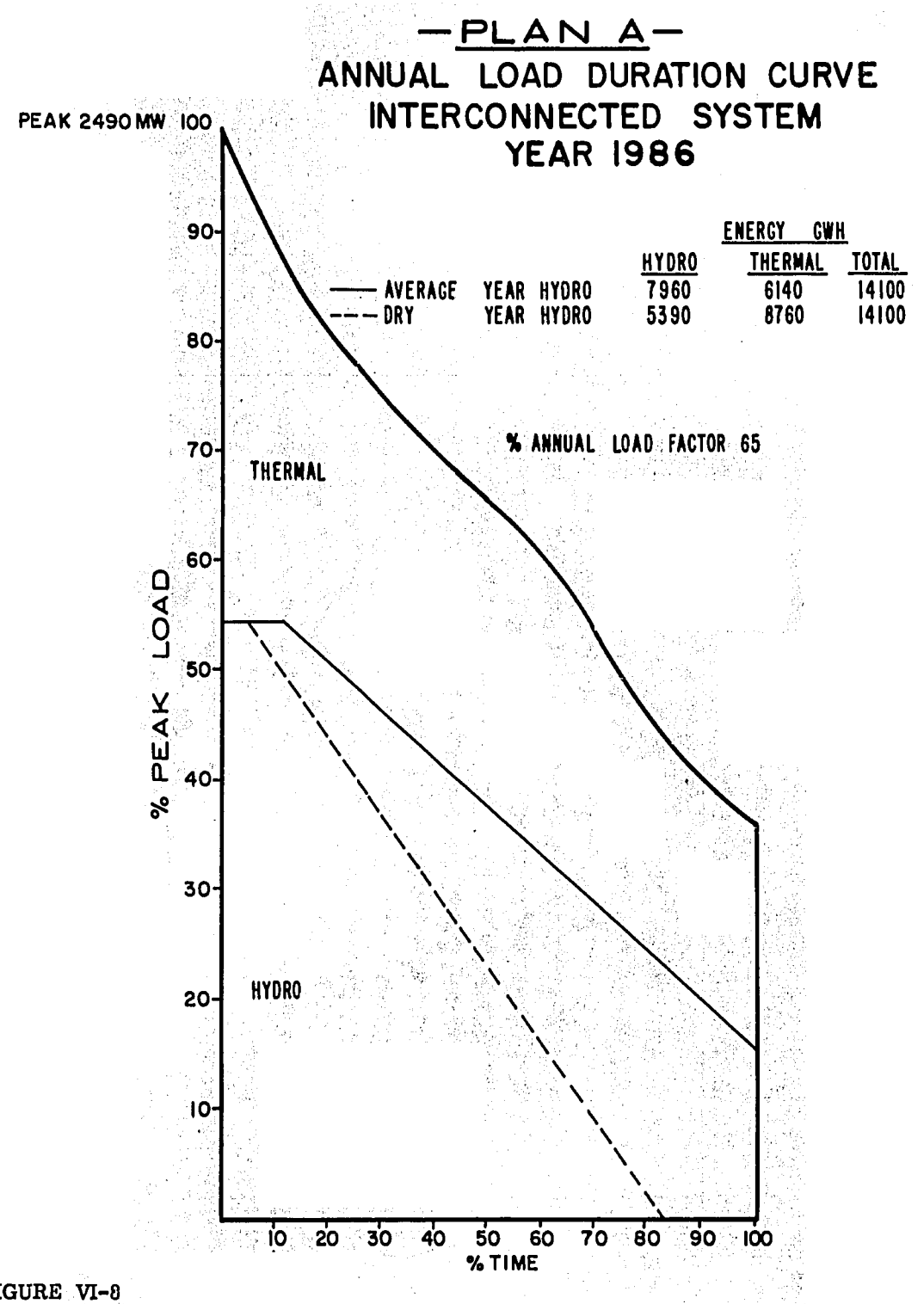

FIGURE VI-8

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FIGURE VI-9

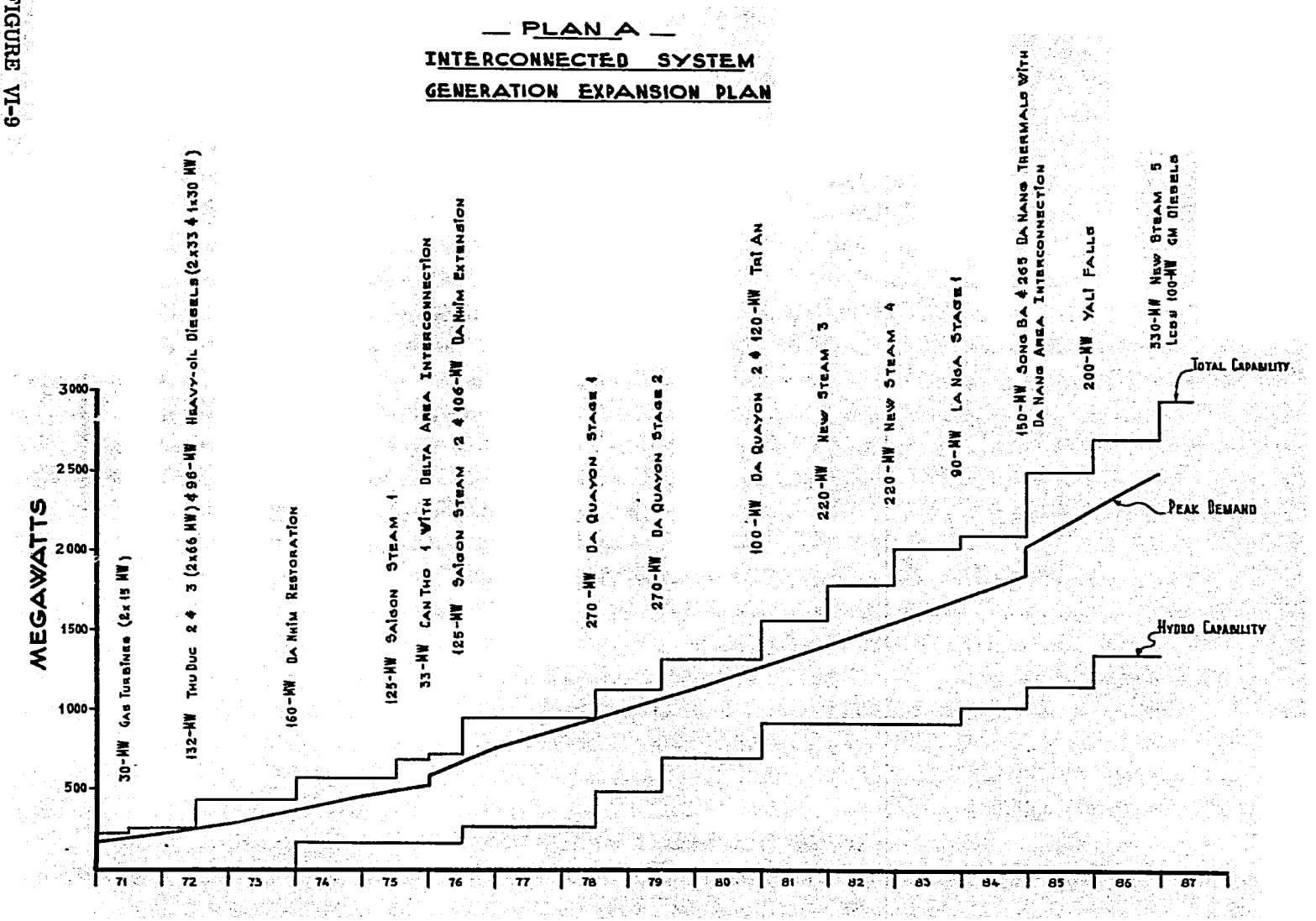

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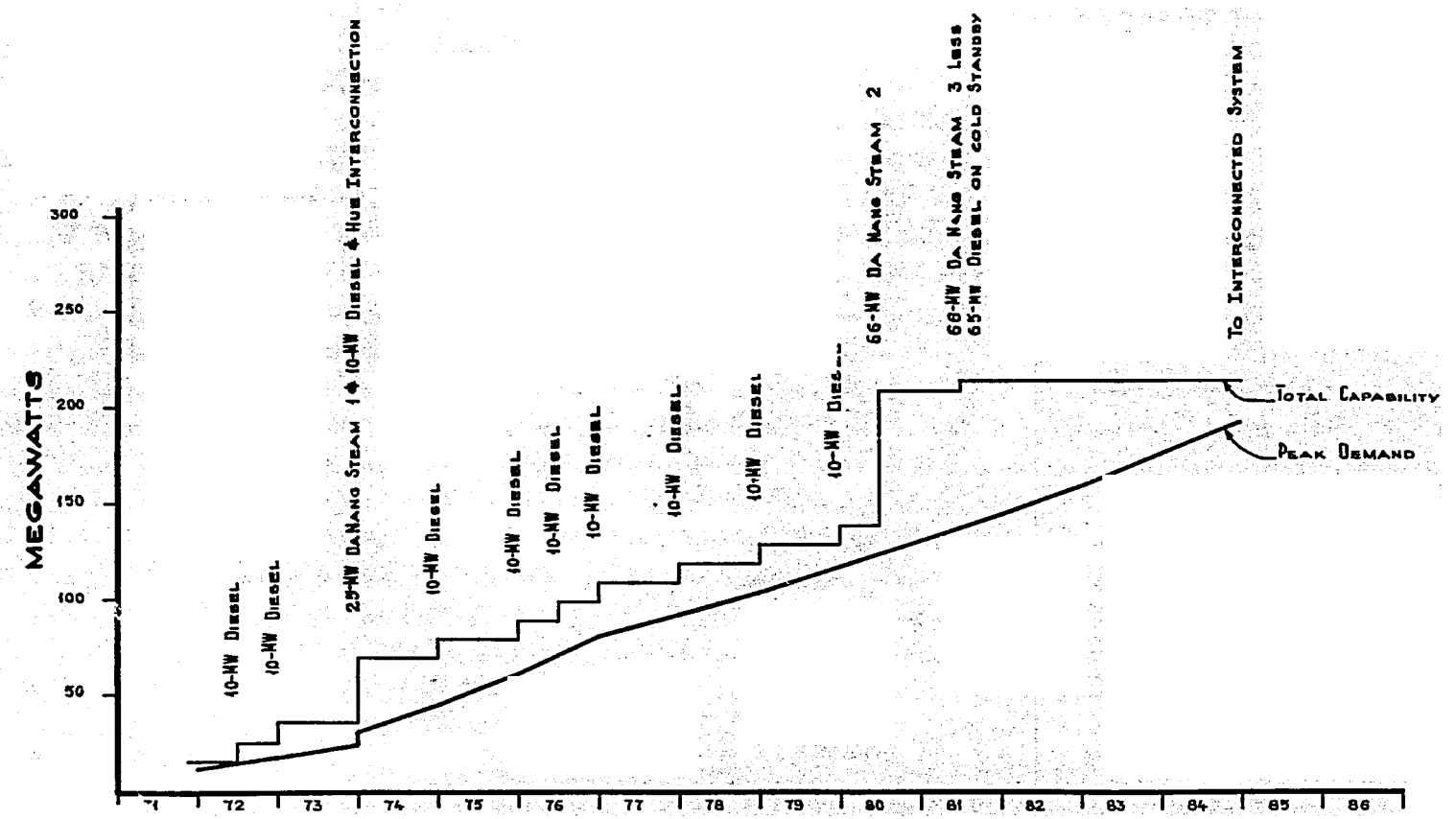
FIGURE VI-10

PLAN A & C
DA NANG AREA SYSTEM
GENERATION EXPANSION PLAN



126

FIGURE VI-11

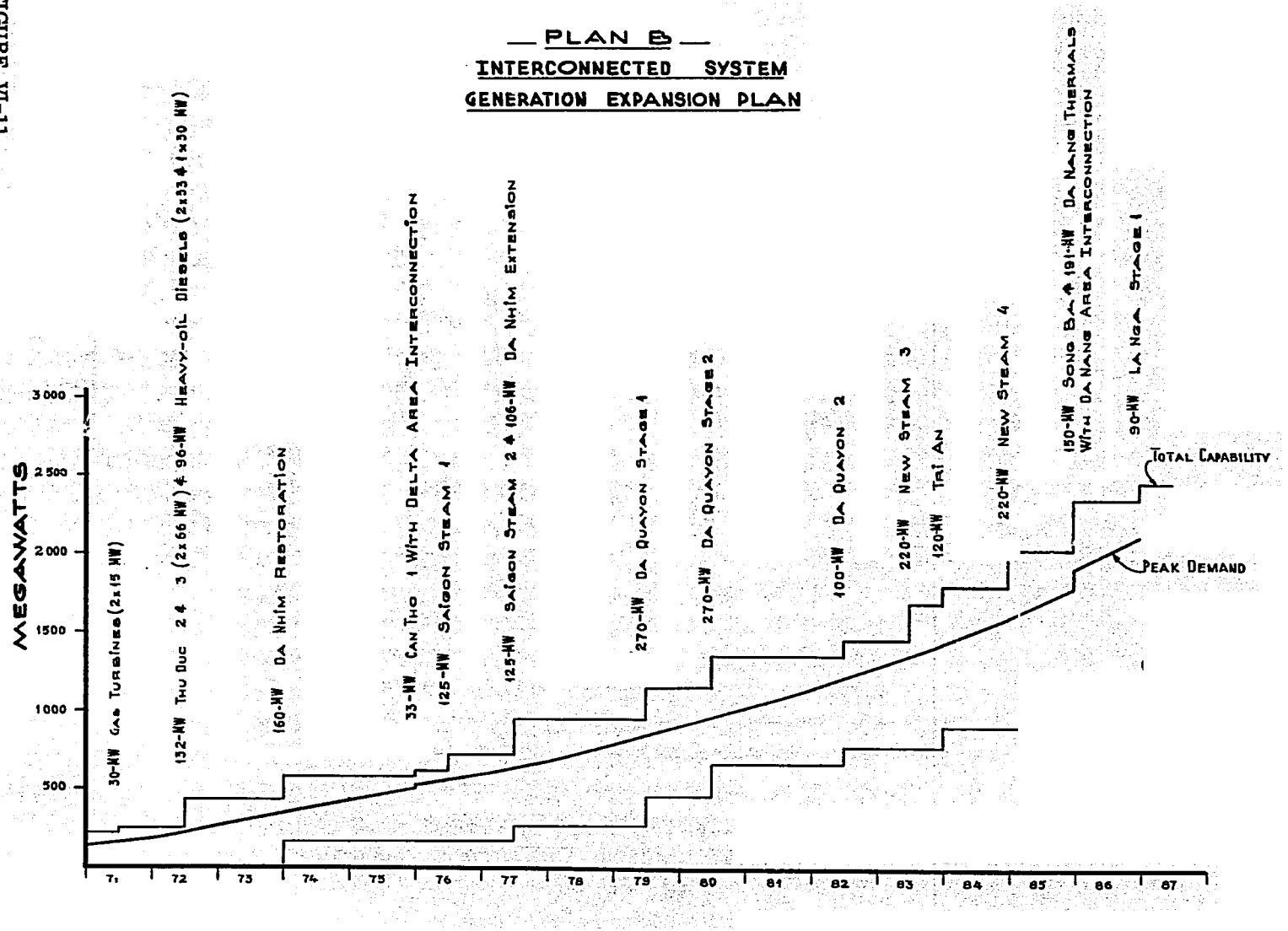

PLAN B
INTERCONNECTED SYSTEM
GENERATION EXPANSION PLAN
MEGAWATTS
3000
2500
2000
1500
1000
500
30-MW GAS TURBINES (2x15 MW)
132-MW THU DUC 2 & 3 (2x66 MW) & 96-MW HEAVY-OIL DIESELS (2x33 & 1x30 MW)
160-MW DA NHIM RESTORATION
33-MW CAN THO 1 WITH DELTA AREA INTERCONNECTION
125-MW SAIGON STEAM 1
125-MW SAIGON STEAM 2 & 106-MW DA NHIM EXTENSION
270-MW DA QUAYON STAGE 1
270-MW DA QUAYON STAGE 2
100-MW DA QUAYON 2
220-MW NEW STEAM 3
120-MW TRI AN
220-MW NEW STEAM 4
150-MW SONG BA & 191-MW DA NANG THERMALS WITH DA NANG AREA INTERCONNECTION
90-MW LA NGA STAGE 1
TOTAL CAPABILITY
PEAK DEMAND
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87

FIGURE VI-12

— PLAN B —
DA NANG AREA SYSTEM
GENERATION EXPANSION PLAN

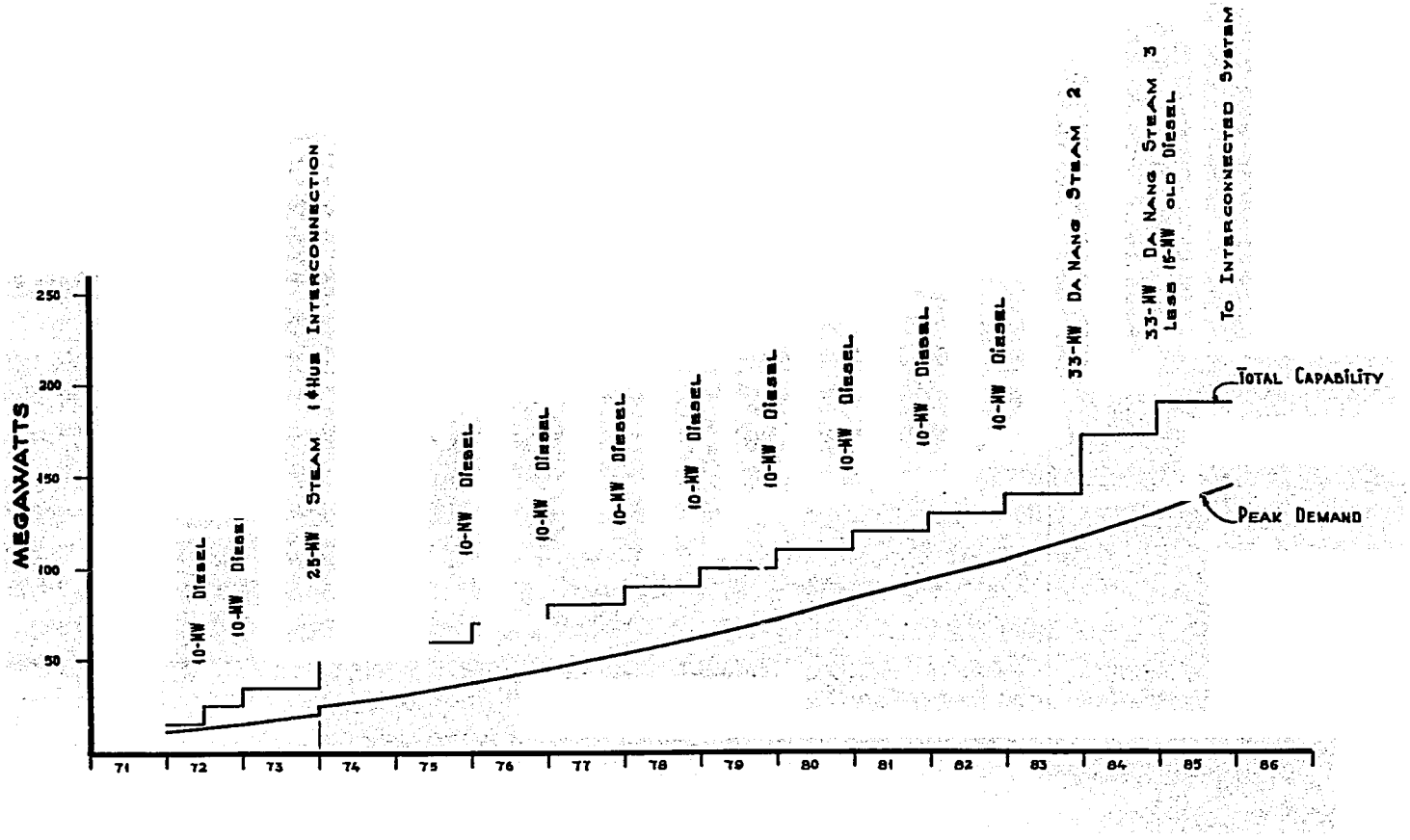


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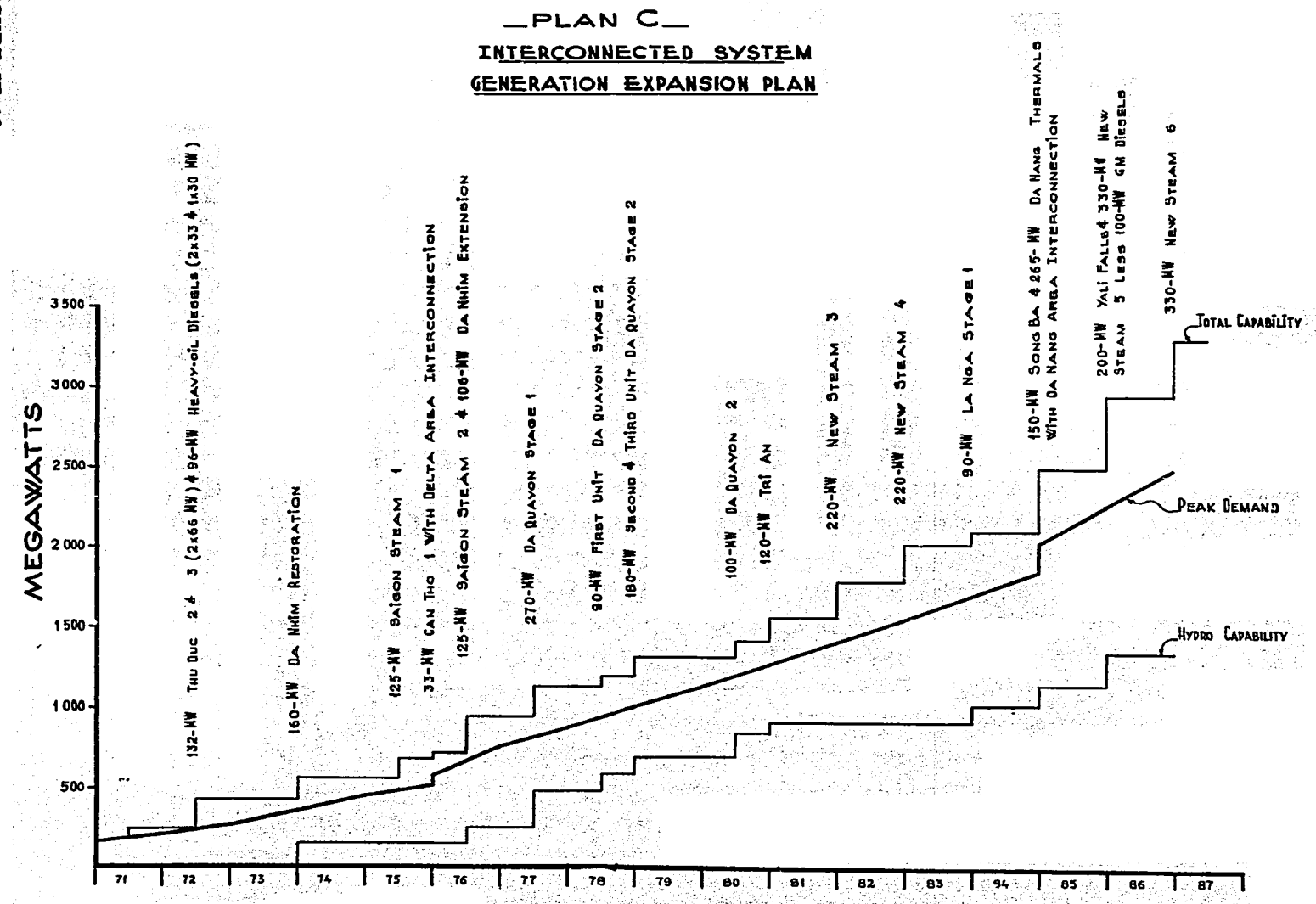
FIGURE VI-13



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EXISTING VPC TRANSMISSION SYSTEM
1971

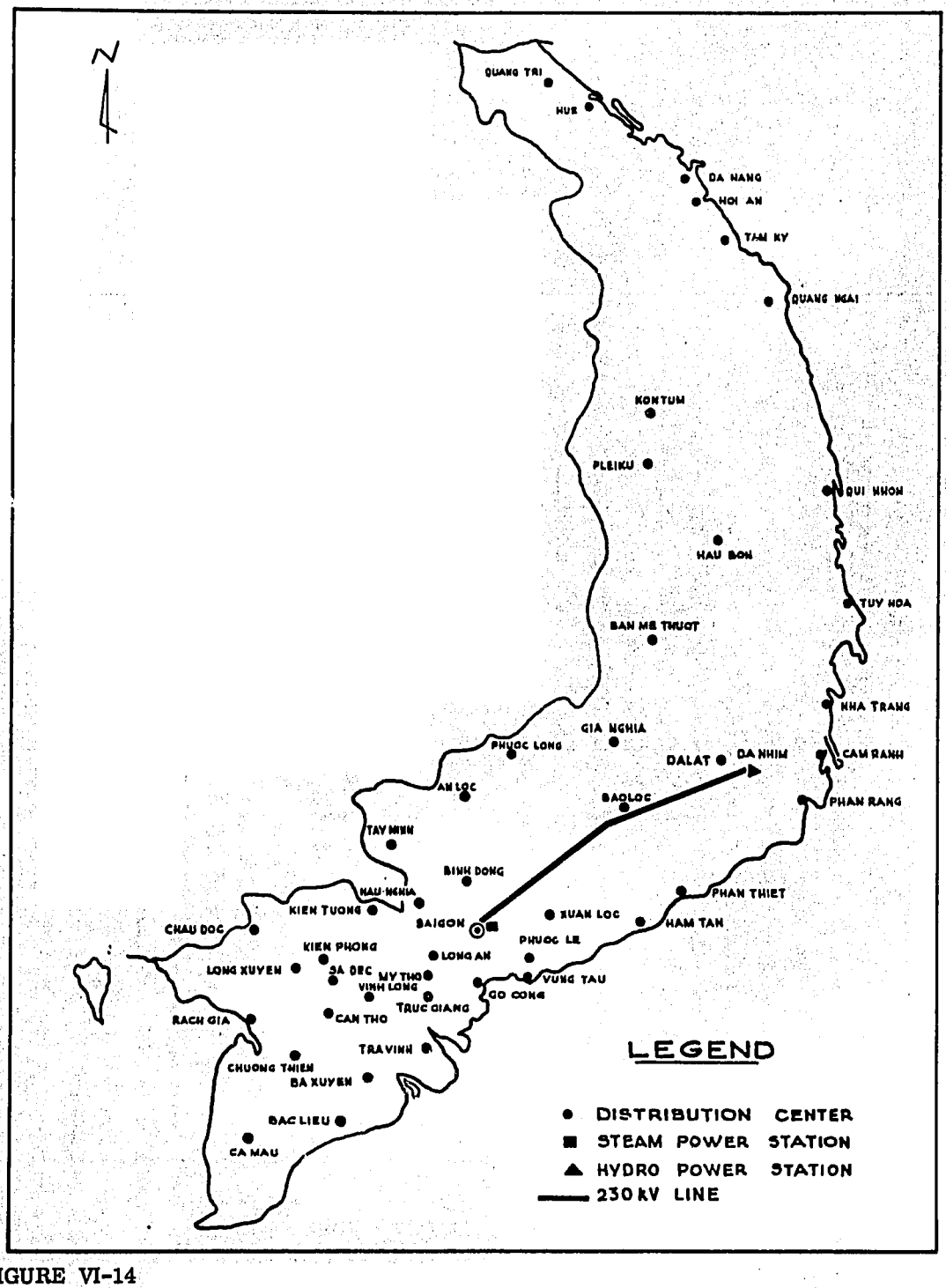


FIGURE VI-14

130

TRANSMISSION SYSTEM STUDY
1976

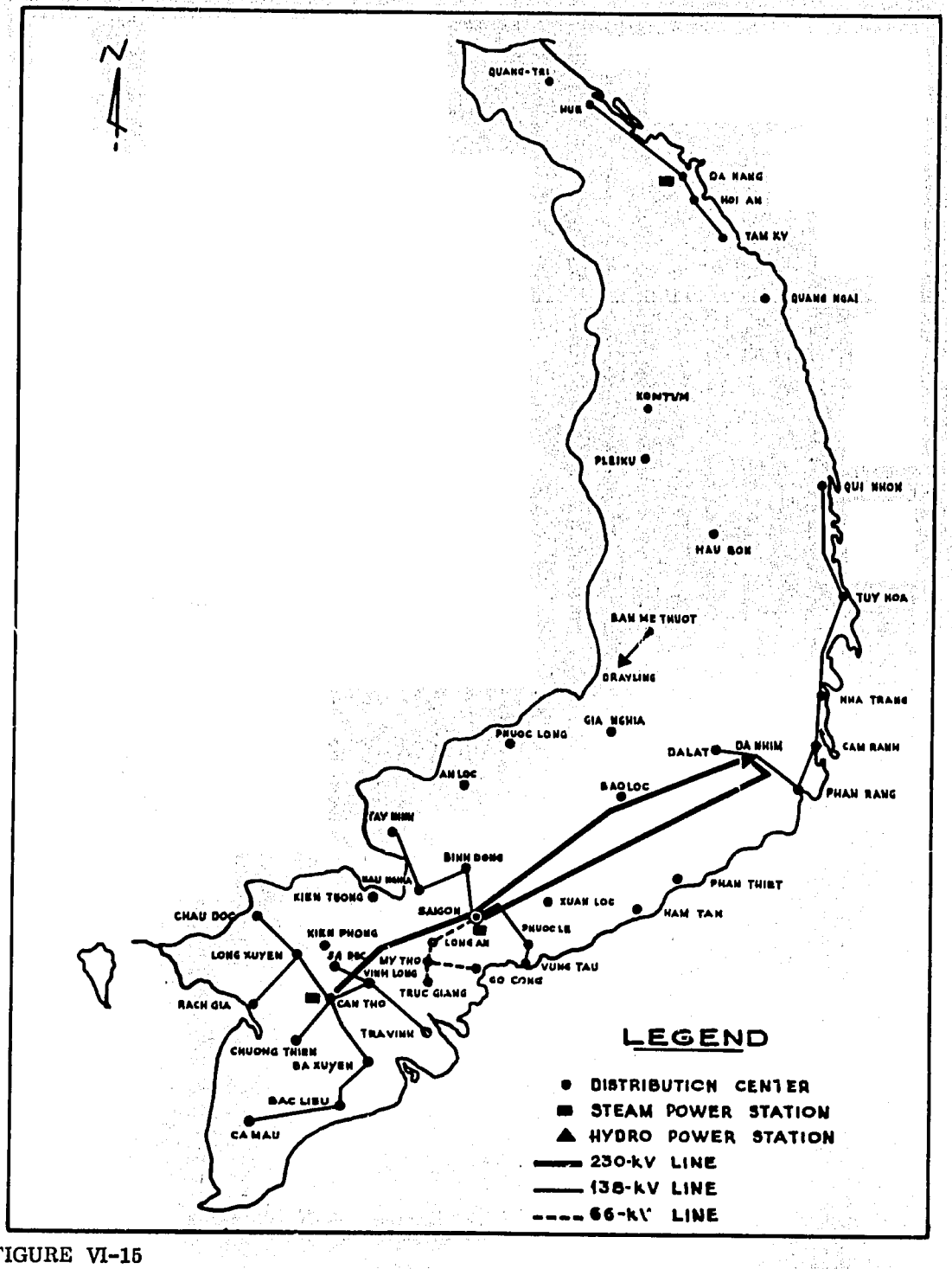


FIGURE VI-15

131

VPC TRANSMISSION SYSTEM STUDY
1981

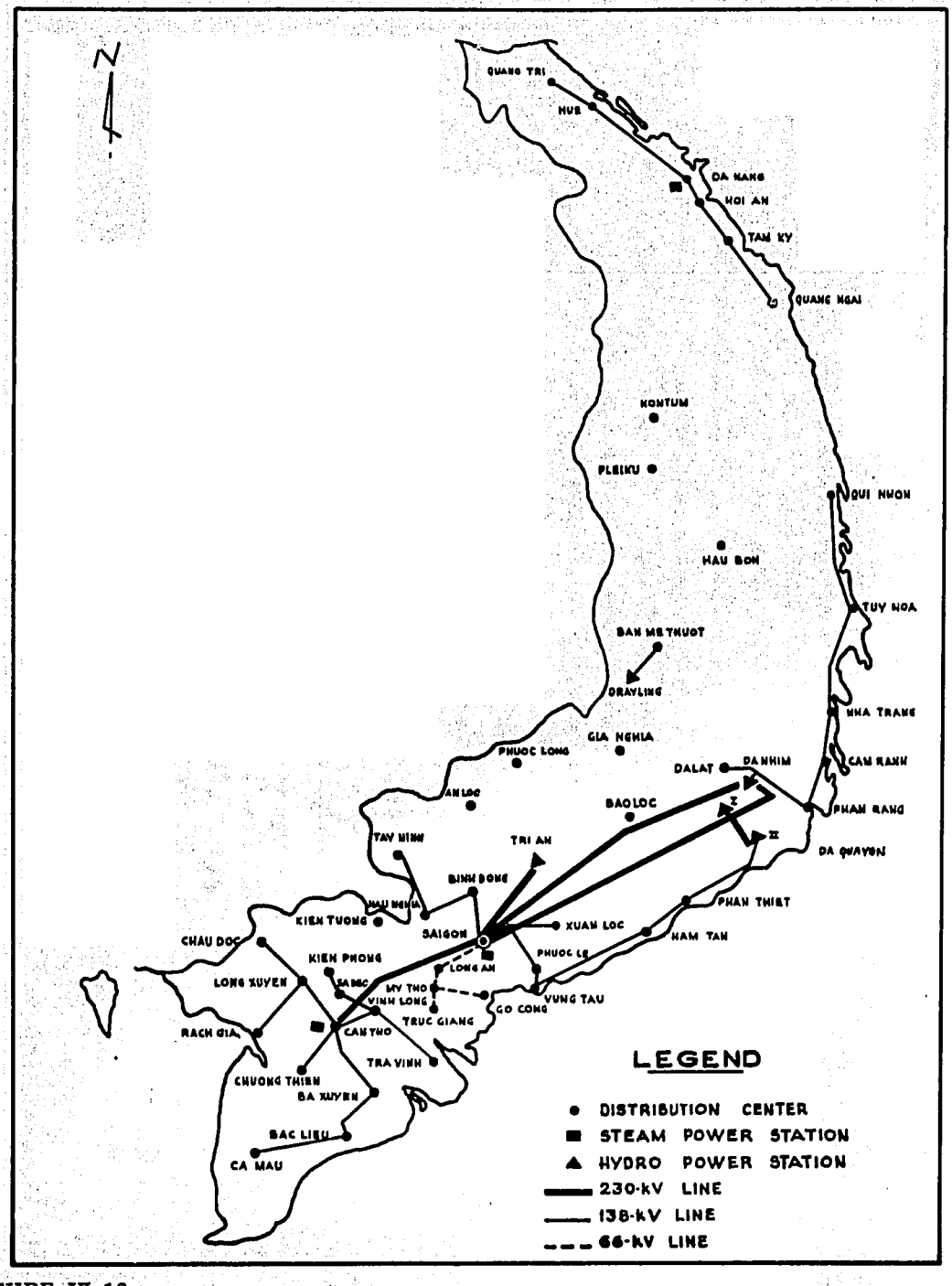


FIGURE VI-16

VPC TRANSMISSION SYSTEM STUDY 1986

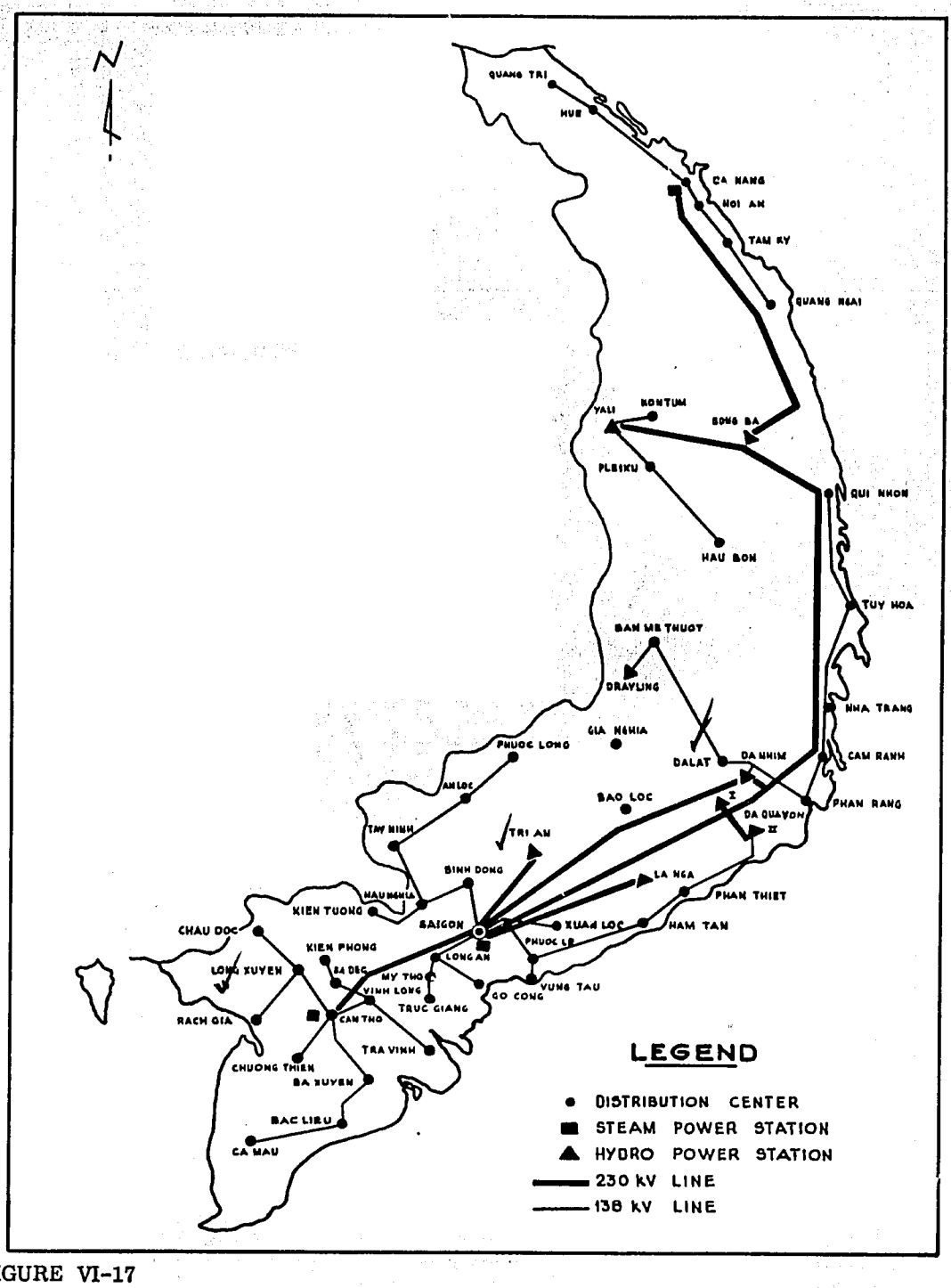


FIGURE VI-17

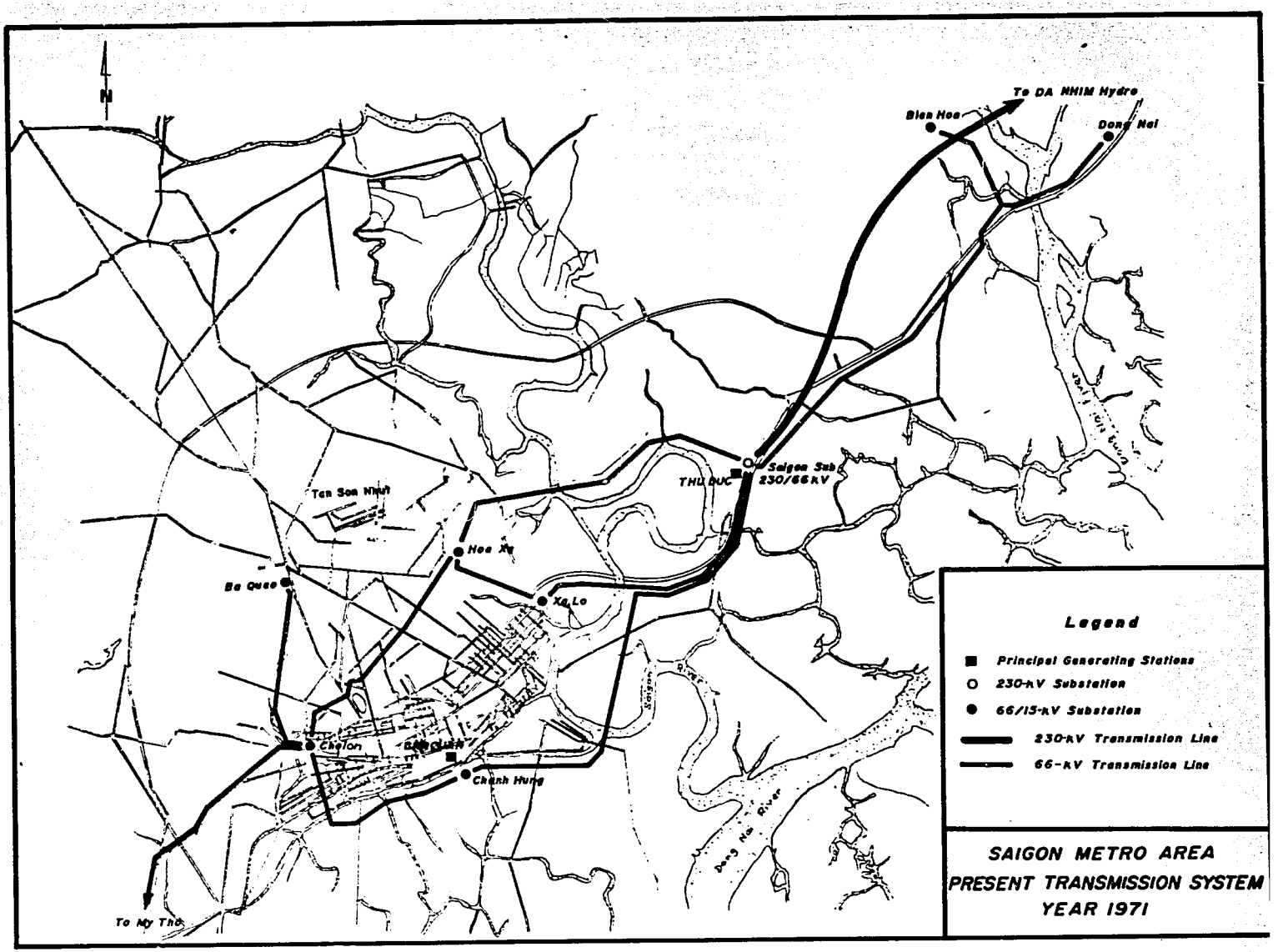

N
To DA NHIM Hydro
Bien Hoa
Dong Nai
Saigon Sub
230/66 kV
THU DUC
Tan Son Nhut
Hoc Mon
Ba Quoc
Xa Lo
Cholon
Saigon
Chanh Hung
To My Tho
Legend
Principal Generating Stations
230-kV Substation
66/15-kV Substation
230-kV Transmission Line
66-kV Transmission Line
SAIGON METRO AREA
PRESENT TRANSMISSION SYSTEM
YEAR 1971

FIGURE VI-18

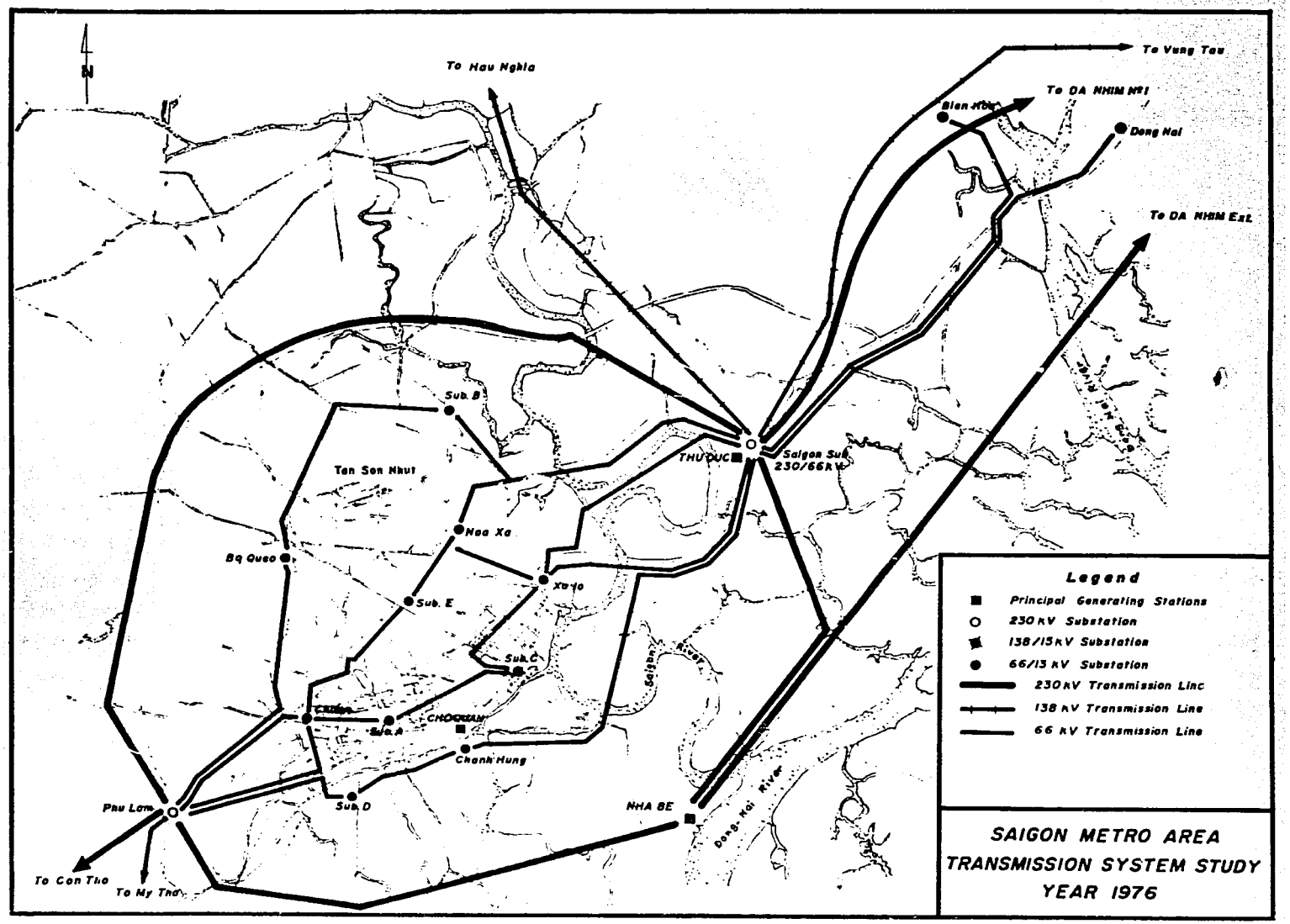

To Hau Nghia
To Vung Tau
To DA NHIM Nt
Bien Hoa
Dong Nai
To DA NHIM Est
Sub. B
Tan Son Nhut
THU DUC
Saigon Sub
230/66kV
Nhe Xa
Bq Quoc
Xa lo
Sub. E
Sub. C
Saigon River
CHOGRAM
Sub. A
Chanh Hung
Sub. D
Phu Lam
NHA BE
Dong Nai River
To Can Tho
To My Tho
Legend
Principal Generating Stations
230 kV Substation
138/15 kV Substation
66/13 kV Substation
230 kV Transmission Line
138 kV Transmission Line
66 kV Transmission Line
SAIGON METRO AREA
TRANSMISSION SYSTEM STUDY
YEAR 1976

FIGURE VI-19

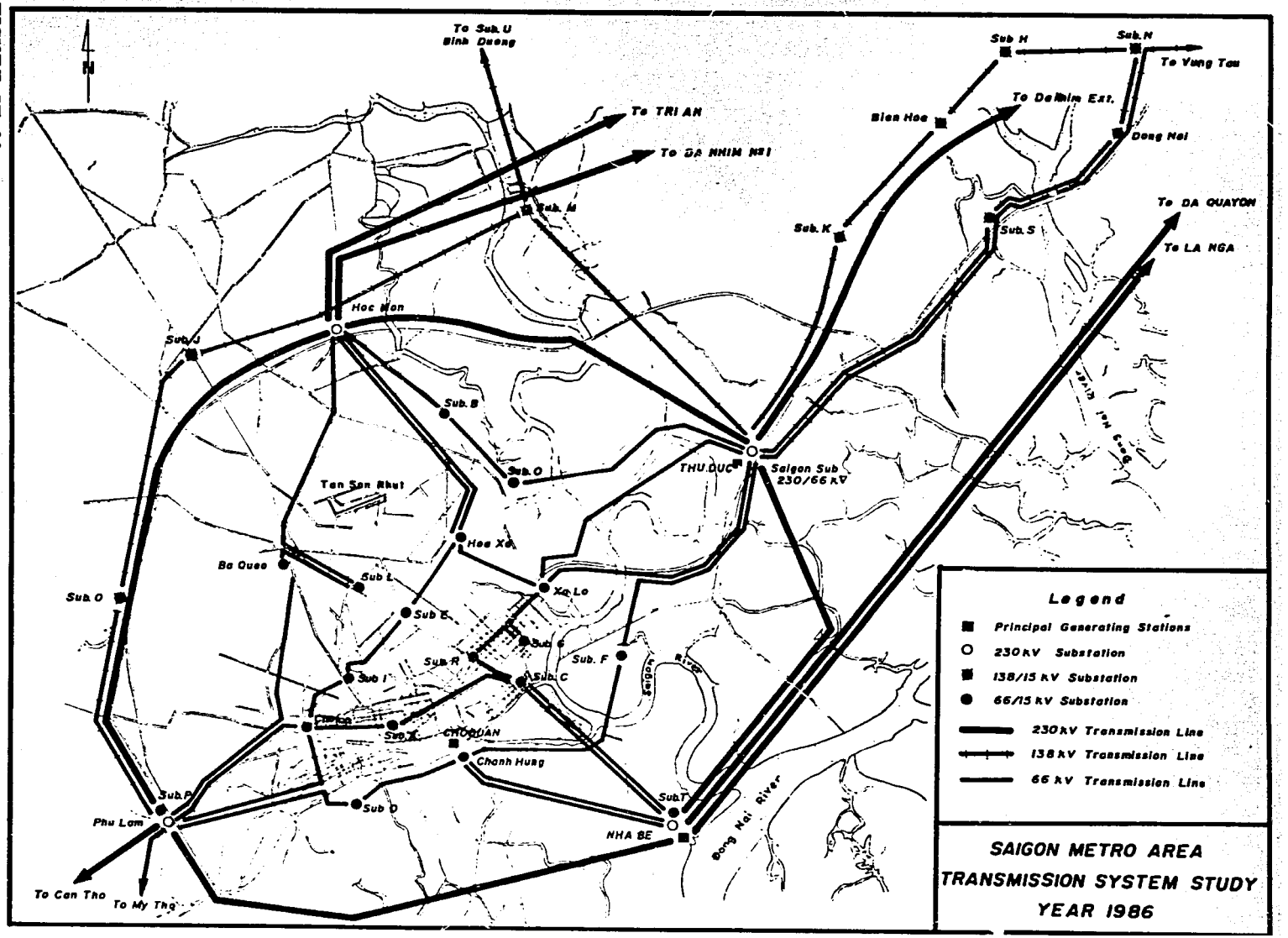
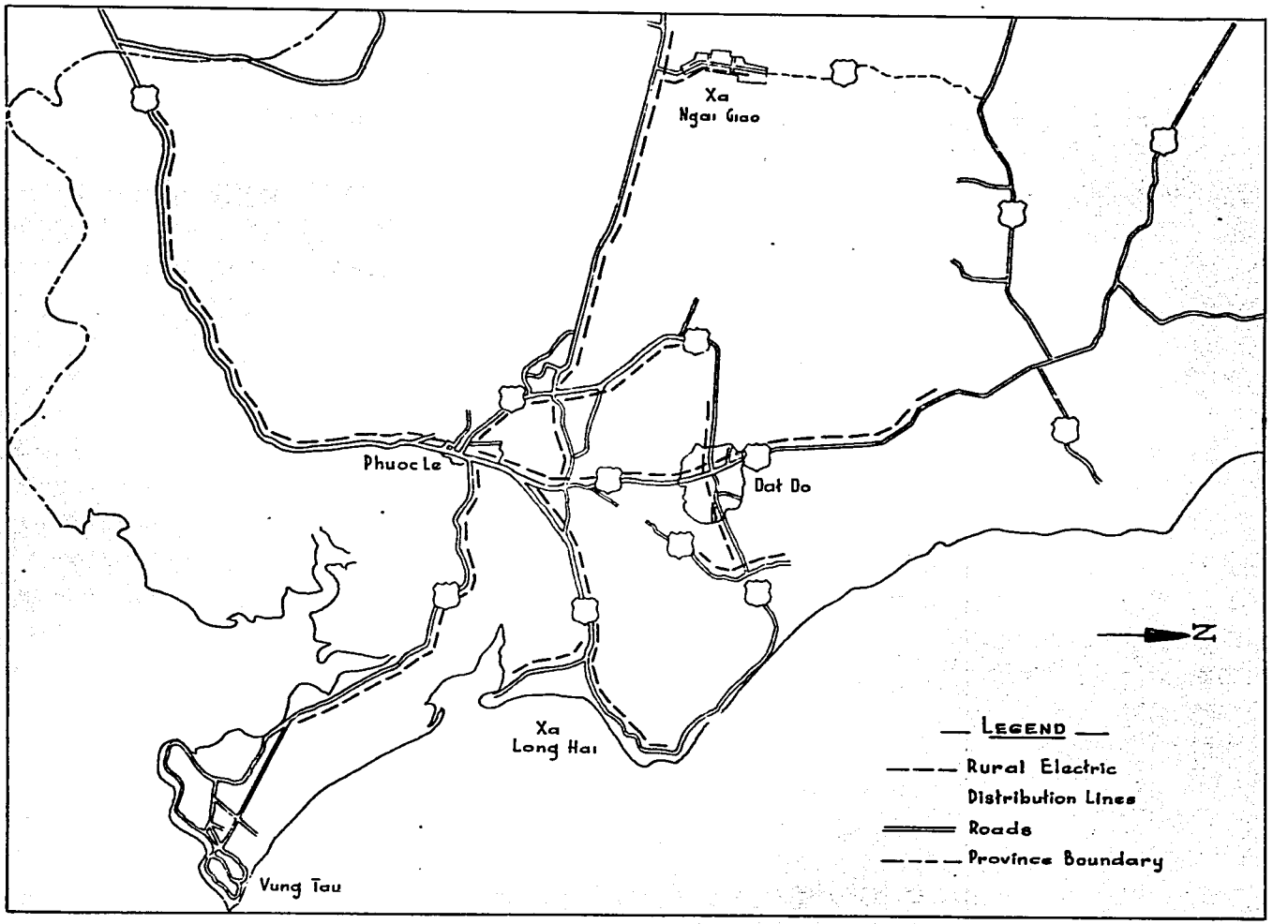

To Sub. U
Binh Duong
To TRI AN
To DA NHIM NO I
Sub. M
Sub. H
Sub. N
To Vung Tau
Bien Hoa
To Da Nhim Ext.
Dong Nai
To DA QUAYON
To LA NGA
Sub. K
Sub. S
Hoc Mon
Sub. J
Sub. B
Sub. O
THU DUC
Saigon Sub
230/66 kV
Tan Son Nhut
Hoa Xa
Ba Quea
Sub. L
Sub. O
Xa Lo
Sub. E
Sub. G
Sub. F
Sub. R
Sub. C
Sub. I
Saigon River
Sub. X
CHOQUAN
Chanh Hung
Sub. P
Sub. D
Sub. T
Phu Lam
NHA BE
Dong Nai River
To Can Tho
To My Tho
Legend
Principal Generating Stations
230 kV Substation
138/15 kV Substation
66/15 kV Substation
230 kV Transmission Line
138 kV Transmission Line
66 kV Transmission Line
SAIGON METRO AREA
TRANSMISSION SYSTEM STUDY
YEAR 1986

FIGURE VI-20

FIGURE VI-21



A TYPICAL RURAL ELECTRIC DISTRIBUTION SYSTEM

TABLE VI-1

PLANS A and C
TOTAL VIETNAM LOAD
SUBDIVIDED BY REGIONS - SEVEN PERCENT GNP CURVE

(Four Digit Numbers Rounded to Nearest Ten)

Peak – Megawatt	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Saigon Metropolitan Area*	216	263	335	405	475	593	674	765	861	957	1 070	1 180	1 300	1 420	1 560	1 700
Province Connections	3	6	21	40	107**	171	232	265	300	343	393	430	481	533	808***	920
Interconnected System	219	269	356	445	582	764	906	1 030	1 160	1 300	1 460	1 610	1 780	1 950	2 370	2 620
Coincidence Factor-Percent	100	100	100	100	99.5	99.0	98.5	98.0	97.5	97.0	96.5	96.0	95.5	95.0	95.0	95.0
Coincident Peak-Interconnected System	219	269	356	445	580	756	893	1 010	1 130	1 260	1 410	1 550	1 700	1 850	2 250	2 490
Da Nang Area	–	–	33	44	64	82	92	103	119	134	147	159	181	193	–	–
Isolated Systems	80	113	100	119	81**	52	62	66	71	66	63	71	69	87	94	64
Total-VN Noncoincident Peak*	299	382	489	608	727	898	1 060	1 200	1 350	1 500	1 670	1 840	2 030	2 230	2 460	2 680
Percent Increase	–	28	28	25	20	24	18	14	13	11	11	10	10	10	10	9
Energy – Gigawatthours																
Saigon Metropolitan Area*	1 130	1 400	1 790	2 200	2 580	3 270	3 790	4 350	4 940	5 450	6 180	6 780	7 450	8 180	9 000	9 840
Province Connections	12	24	85	165	440	660	920	1 180	1 290	1 520	1 710	1 920	2 230	2 430	3 660	4 260
Interconnected System	1 140	1 420	1 870	2 360	3 020	3 930	4 710	5 530	6 230	6 970	7 890	8 700	9 680	10 610	12 660	14 100
Da Nang Area	–	–	133	181	263	345	380	434	552	586	685	710	798	880	–	–
Isolated Systems	309	430	367	450	287**	205	240	256	268	254	245	300	282	370	460	310
Total Vietnam*	1 450	1 850	2 370	2 990	3 570	4 480	5 330	6 220	7 050	7 810	8 820	9 710	10 760	11 860	13 120	14 410
Percent Increase	–	28	28	26	20	25	19	17	13	11	12	11	11	10	10	10
Percent Load Factor																
Saigon Metropolitan Area	60	61	61	62	62	63	64	65	65	65	65	65	65	65	66	66
Provinces	45	46	46	47	47	48	48	49	49	50	50	51	51	52	52	53
Interconnected System	59	60	60	60	60	60	61	62	62	63	64	64	65	65	65	65

*1971-1976 Inc – VPC 7/71 Load Forecast
**Delta area interconnected
***Da Nang area interconnected

TABLE VI-2

INTERCONNECTED SYSTEM PEAK GENERATION CAPABILITY

Plants	Rating	1971	1972	1973	1974	1975	1976*	1977	1978	1979	1980	1981	1982	1983	1984	1985**	1986
	Megawatts (Four Digit Numbers Rounded to Nearest Ten)																
Thermal-Steam																	
Thu Duc 1	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
Choquan	36	36	20***	20	20	20	†	–	–	–	–	–	–	–	–	–	–
Thu Duc 2&3 (2x66MW)	132	–	140††	140	140	140	140	140	140	140	140	140	140	140	140	140	140
Can Tho 1	33	–	–	–	–	–	33	33	33	33	33	33	33	33	33	33	33
Da Nang 1	25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	25	25
Saigon 1	125	–	–	–	–	132††	132	132	132	132	132	132	132	132	132	132	132
Saigon 2	125	–	–	–	–	–	132††	132	132	132	132	132	132	132	132	132	132
New Steam 3	220	–	–	–	–	–	–	–	–	–	–	–	233††	233	233	233	233
New Steam 4	220	–	–	–	–	–	–	–	–	–	–	–	–	233††	233	233	233
Da Nang 2&3 (2x66MW)	132	–	–	–	–	–	–	–	–	–	–	–	–	–	–	140††	140
Total Steam		69	193	193	193	325	470	470	470	470	470	470	703	936	936	1 100	1 100
Thermal-Diesel & Gas Turbine																	
Old Diesel	37	23***	Retire	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gas Turbine (3x15MW; 1x12.5MW)	58	58	58	56	58	58	58	58	58	58	58	58	58	58	58	58	58
New Heavy Oil Diesel (12x5.5MW; 10x3MW)	96	–	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96
GM Diesel (56x2.1MW)	118	100***	80†††	80	60	50	30	20	10	10	10	10	10	10	10	100#	100
Total Diesel		181	234	234	214	204	184	174	164	154	154	154	154	154	154	254	254
Total Thermal		250	427	427	407	529	654	644	634	624	624	624	857	1 090	1 090	1 350	1 350
Hydro																	
Da Nhim Restoration	160	–	–	–	160	160	160	160	160	160	160	160	160	160	160	160	160
Da Nhim Extension	106	–	–	–	–	–	106	106	106	106	106	106	106	106	106	106	106
Da Quayon Stage 1	270	–	–	–	–	–	–	–	226##	228	228	228	228	228	228	228	228
Da Quayon Stage 2	270	–	–	–	–	–	–	–	–	206##	206	206	206	206	206	206	206
Da Quayon 2	100	–	–	–	–	–	–	–	–	–	–	100	100	100	100	100	100
Tri An	120	–	–	–	–	–	–	–	–	–	–	120	120	120	120	120	120
Drayling	12	–	–	–	–	–	–	–	–	–	–	12	12	12	12	12	12
La Nga Stage 1	90	–	–	–	–	–	–	–	–	–	–	–	–	–	80***	80	80
Song Ba	150	–	–	–	–	–	–	–	–	–	–	–	–	–	–	138***	138
Yali Falls	200	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	200
Total Hydro		–	–	–	160	160	266	266	494	700	700	932	932	932	1 010	1 150	1 350
Total Hydro and Thermal		250	427	427	567	689	920	910	1 130	1 320	1 320	1 560	1 790	2 020	2 100	2 500	2 700
Less Load Requirements		(219)	(269)	(356)	(445)	(580)	(756)	(893)	(1 010)	(1 130)	(1 260)	(1 410)	(1 550)	(1 700)	(1 850)	(2 250)	(2 490)
Margin		31	158	71	122	109	164	17	140	190	60	150	240	320	250	250	210

*Delta area interconnected
**Da Nang area interconnected
***Dependable capacity
†Placed on Cold Standby in 1976
††Rating with six percent overload
†††GM diesels are progressively relocated to Da Nang area.
GM diesels available for peak reserve
Net after pumping requirements

TABLE VI-2

TABLE VI-3

PLAN A
INTERCONNECTED SYSTEM - ENERGY GENERATION CAPABILITY - DRY YEAR HYDRO CONDITIONS

Plant	Rating MW	Avail Factr %	Annual Energy Cap	1971	1972	1973	1974	1975	1976*	1977	1978	1979	1980	1981	1982	1983	1984	1985**	1986
				Gigawatthours (Four Digit Numbers Rounded to Nearest Ten)															
Thermal – Steam																			
Choquan	20***	80	140	140	140	140	140	140	#	–	–	–	–	–	–	–	–	–	–
Thu Duc 1	33	90	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260
Thu Duc 2 & 3	132	90	1 040	–	520♦	1 040	1 040	1 040	1 040	1 040	1 040	1 040	1 040	1 040	1 040	1 040	1 040	1 040	1 040
Can Tho 1	33	90	260	–	–	–	–	–	260	260	260	260	260	260	260	260	260	260	260
Saigon 1	125	90	980	–	–	–	–	490♦	980	980	980	980	980	980	980	980	980	980	980
Saigon 2	125	90	980	–	–	–	–	–	490♦	980	980	980	980	980	980	980	980	980	980
New Steam 3	220	90	1 740	–	–	–	–	–	–	–	–	–	–	–	1 740	1 740	1 740	1 740	1 740
New Steam 4	220	90	1 740	–	–	–	–	–	–	–	–	–	–	–	–	1 740	1 740	1 740	1 740
Da Nang 1	25	80	170	–	–	–	–	–	–	–	–	–	–	–	–	–	–	170	170
Da Nang 2 & 3	132	90	1 040	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 040	1 040
Total Steam				400	920	1 440	1 440	1 930	3 030	3 520	3 520	3 520	3 520	3 520	5 260	7 000	7 000	8 210	8 210
Therm–Diesel & Gas Turb																			
Old Diesel	23	50	100	100	Retire	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gas Turbines	58	40	200	150●	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
New Heavy Oil Diesels	96	70	590	–	440●	590	590	590	590	590	590	590	590	590	590	590	590	590	590
GM Diesels	100***	60	530	530	420†	420	320	260	160	110	50	–	–	–	–	–	–	0‡	–
Total Diesel				780	1 060	1 210	1 110	1 050	950	900	840	790	790	790	790	790	790	790	790
Total Thermal				1 180	1 980	2 650	2 550	2 980	3 980	4 420	4 360	4 310	4 310	4 310	6 050	7 790	7 790	9 000	9 000
Hydro		Dry Year Load Fctr %																	
Da Nhim Restoration	160	51	720	–	–	–	720	720	720	720	720	720	720	720	720	720	720	720	720
Da Nhim Extension	106	45	430	–	–	–	–	–	210♦	430	430	430	430	430	430	430	430	430	430
Da Quayon Stage 1	270	50	1 000+	–	–	–	–	–	–	–	500♦	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000
Da Quayon Stage 2	270	42	750+	–	–	–	–	–	–	–	–	370♦	750	750	750	750	750	750	750
Da Quayon 2	100	69	600	–	–	–	–	–	–	–	–	–	–	600	600	600	600	600	600
Tri An	120	32	330	–	–	–	–	–	–	–	–	–	–	330	330	330	330	330	330
Drayling	12	47	50	–	–	–	–	–	–	–	–	–	–	50	50	50	50	50	50
La Nga Stage 1	90	37	290	–	–	–	–	–	–	–	–	–	–	–	–	–	290	290	290
Song Ba	150	57	750	–	–	–	–	–	–	–	–	–	–	–	–	–	–	750	750
Yali Falls	200	27	470	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	470
Total Hydro				–	–	–	720	720	930	1 150	1 650	2 520	2 900	3 880	3 880	3 880	4 170	4 920	5 390
Total Hydro and Thermal				1 180	1 980	2 650	3 270	3 700	4 910	5 570	6 010	6 830	7 210	8 190	9 930	11 670	11 960	13 920	14 390
Less Load Requirements				(1 140)	(1 420)	(1 870)	(2 360)	(3 020)	(3 930)	(4 710)	(5 350)	(6 230)	(6 970)	(7 890)	(8 700)	(9 680)	(10 610)	(12 660)	(14 100)
Margin				40	560	780	910	680	980	860	660	600	240	300	1 230	1 990	1 350	1 260	290
Percent Margin				3	39	42	39	22	25	18	12	10	3	4	14	20	13	10	2

* Delta area interconnected 1/76.
** Da Nang area interconnected 1/85.
*** Dependable capacity.
\# Placed on cold standby in 1976

♦ One-half year operation.
● Three-quarter year operation.
† GM diesels progessively removed (See Plan A peak generation capacity)

‡ Assume GM diesels as available reserve capacity only.
\+ Net after pumping requirements

TABLE VI-3

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TABLE VI-4

PLAN A and C
DA NANG AREA - PEAK GENERATION CAPACITY

Plant	Rating	Megawatts 1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985*
Steam															
Da Nang Steam 1	25	–	–	25	25	25	25	25	25	25	25	25	25	25	
Da Nang Steam 2	66	–	–	–	–	–	–	–	–	70	70	70	70	70	
Da Nang Steam 3	66	–	–	–	–	–	–	–	–	–	70	70	70	70	
Total Steam		–	–	25	25	25	25	25	25	95	165	165	165	165	
Diesel															
Existing and Scheduled	15	15	15	15	15	15	15	15	15	15	**	–	–	–	
GM Units	100***	10	20	30	40	60	70	80	90	100	100	100	100	100	
Total Diesel		25	35	45	55	75	85	95	105	115	100	100	100	100	
Total Thermal		25	35	70	80	100	110	120	130	210	265	265	265	265	
Less Load Requirement		(18)	(24)	(44)	(64)	(82)	(92)	(103)	(119)	(134)	(147)	(159)	(181)	(193)	
Margin		7	11	26	16	18	18	17	11	76	118	106	84	72	

* Part of interconnected system.
** Deactivate or retire.
*** GM units transferred from Saigon.

TABLE VI-4

TABLE VI-5

PLAN B
PEAK GENERATION CAPABILITY

Interconnected System	Megawatts (Four Digit Numbers Rounded to Nearest Ten)														
	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Plan A Capacity	427	427	567	689	920	910	1130	1320	1320	1560	1790	2020	2100	2500	2700
Plus GM Diesels not transferred*	10	–	20	30	40	40	40	40	30	20	10	–	–	–	–
Total	437	427	587	719	960	950	1170	1360	1350	1580	1800	2020	2100	2500	2700
Less Plant Deferrals															
Saigon Steam 1	–	–	–	(132)	–	–	–	–	–	–	–	–	–	–	–
Saigon Steam 2	–	–	–	–	(132)	–	–	–	–	–	–	–	–	–	–
Da Nhim Extension	–	–	–	–	(106)	–	–	–	–	–	–	–	–	–	–
Da Quayon Stage 1	–	–	–	–	–	–	(228)	–	–	–	–	–	–	–	–
Da Quayon Stage 2	–	–	–	–	–	–	–	(206)	–	–	–	–	–	–	–
Da Quayon 2	–	–	–	–	–	–	–	–	–	(100)	–	–	–	–	–
Tri An	–	–	–	–	–	–	–	–	–	(120)	(120)	(120)	–	–	–
New Steam 3	–	–	–	–	–	–	–	–	–	–	(233)	–	–	–	–
New Steam 4	–	–	–	–	–	–	–	–	–	–	–	(233)	(233)	–	–
La Nga Stage 1	–	–	–	–	–	–	–	–	–	–	–	–	(80)*	(80)	(80)
Song Ba	–	–	–	–	–	–	–	–	–	–	–	–	–	(138)	–
Yali Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	(200)
Da Nang Thermal	–	–	–	–	–	–	–	–	–	–	–	–	–	(265)	–
Plan B Capacity	437	427	587	587	722	950	942	1150	1350	1360	1450	1670	1790	2020	2340**
Da Nang Area System															
Da Nang Steam 1	–	–	25	25	25	25	25	25	25	25	25	25	25	25	–
Da Nang Steam 2	–	–	–	–	–	–	–	–	–	–	–	–	33	33	–
Da Nang Steam 3	–	–	–	–	–	–	–	–	–	–	–	–	–	33	–
Total Steam	–	–	25	25	25	25	25	25	25	25	25	25	58	91	–
Existing-Scheduled Diesels	15	15	15	15	15	15	15	15	15	15	15	15	15	***	–
GM Diesel units	10	20	20	20	30	40	50	60	70	80	90	100	100	100	–
Total Diesel	25	35	35	35	45	55	65	75	85	95	105	115	115	100	–
Total Thermal	25	35	60	60	70	80	90	100	110	120	130	140	173	191	–

* GM diesels not transferred in Plan A
** Adjusted value to reflect two 33 MW units at Da Nang for Plan B rather than two 60 MW units in Plan A and C
*** Deactivate or relocate

TABLE VI-6

PLAN B
TOTAL VIETNAM LOAD

(Four Digit Numbers Rounded to Nearest Ten)

Peak – Megawatt	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Coincident Peak Interconnected System	269*	356*	445*	500	580	670	780	900	1020	1140	1270	1420	1590	1780	2100
Coincident Factor - Percent	100	100	100	99.5	99.0	98.5	98.0	97.5	97.0	96.5	96.0	95.5	95.0	95.0	95.0
Noncoincident Peak Interconnected System	269	356	445	503	586	680	796	925	1050	1180	1320	1490	1680	1880	2210
Da Nang Area	–	25	30	36	45	55	65	75	85	95	105	120	130	145	–
Isolated Systems	113*	100*	119*	81**	60***	60	60	60	60	60	60	60	60	60	60
Total VN Noncoincident Peak	382	481	594	620	691	795	921	1060	1190	1330	1480	1670	1870	2080	2270
Percent Increase	28	26	24	4	11	15	16	13	12	12	11	13	12	11	9
Energy – Gigawatthours															
Interconnected System	1420	1870	2360	2625	3000	3535	4290	5000	5610	6380	7115	8100	9100	10185	11855
Da Nang Area	–	103	120	140	210	225	270	340	370	440	470	515	590	660	–
Isolated Systems	430	367	450	285	230	230	230	230	230	230	255	255	255	285	295
Total Vietnam	1850	2340	2930	3050	3440	3990	4790	5570	6210	7050	7840	8870	9945	11130	12150
Percent Increase	28	26	25	4	13	16	20	16	12	13	11	13	11	12	9

* Same as Plan A
** Delta area interconnected
*** A lesser amount relative to Plan A average

TABLE VI-6

TABLE VI-7

PLAN C
INTERCONNECTED SYSTEM PEAK GENERATION CAPABILITY

	Plant Commission Date Advancement From Plan A* To	From	Megawatts (Four Digit Numbers Rounded to Nearest Ten) 1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Plan A Capability			250	427	427	567	689	920	910	1130	1320	1320	1560	1790	2020	2100	2500	2700
Da Quayon Stage 1	6-77	6-78	–	–	–	–	–	–	228	–	–	–	–	–	–	–	–	–
Da Quayon Stage 2	6-78** 12-78**	6-79	–	–	–	–	–	–	–	70***	–	–	–	–	–	–	–	–
Da Quayon 2	6-80	12-80	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–	–
New Steam 5	12-85	12-86	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	350
GM Diesel Removal	12-85		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	(100)
Plan C Capability			250	427	427	567	689	920	1140	1200	1320	1420	1560	1790	2020	2100	2500	2950
Less Load Requirement			(219)	(269)	(356)	(445)	(580)	(756)	(893)	(1010)	(1130)	(1260)	(1410)	(1550)	(1700)	(1850)	(2250)	(2490)
Margin			31	158	71	122	109	164	247	190	190	160	150	240	320	250	250	460

* Plants not shown have no change in commission date
** One Unit in 6-78; two units in 12-78
*** Net capacity after pumping requirements

TABLE VI-7

TABLE VI-8

PLAN A
INTERCONNECTED SYSTEM
PLANT PARTICIPATION AND GENERATION SCHEDULE - AVERAGE YEAR HYDRO CONDITIONS

			Gigawatthours (Four Digit Numbers Rounded to Nearest Ten)														
Hydro Plants	Rating MW	Annual Energy Cap.	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Da Nhim Restoration	160	1030	–	–	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030
Da Nhim Extension	106	750	–	–	–	–	370†	750	750	750	750	750	750	750	750	750	750
Da Quayon Stage 1	228*	1550*	–	–	–	–	–	–	770†	1550	1550	1550	1550	1550	1550	1550	1550
Da Quayon Stage 2	206*	1200*	–	–	–	–	–	–	–	600†	1200	1200	1200	1200	1200	1200	1200
Da Quayon 2	100	650	–	–	–	–	–	–	–	–	–	650	650	650	650	650	650
Tri An	120	670	–	–	–	–	–	–	–	–	–	670	670	670	670	670	670
Drayling	12	50	–	–	–	–	–	–	–	–	–	50	50	50	50	50	50
La Nga Stage 1	90	520	–	–	–	–	–	–	–	–	–	–	–	–	520	520	520
Song Ba	150	870	–	–	–	–	–	–	–	–	–	–	–	–	–	870	870
Yali Falls	200	670	–	–	–	–	–	–	–	–	–	–	–	–	–	–	670
Total Hydro			–	–	1030	1030	1400	1780	2550	3930	4530	5900	5900	5900	6420	7290	7960
Load Requirement			1420	1870	2360	3020	3930	4710	5530	6230	6970	7890	8700	9680	10610	12660	14100
Less Hydro			–	–	(1030)	(1030)	(1400)	(1780)	(2550)	(3930)	(4530)	(5900)	(5900)	(5900)	(6420)	(7290)	(7960)
Thermal Requirements			1420	1870	1330	1990	2530	2930	2980	2300	2440	1990	2800	3780	4190	5370	6140
Thermal Plants																	
Thu Duc 1	33	260	230	230	150	200	100	100	100	100	100	100	50	50	50	100	100
Thu Duc 2 & 3	132	1040	460†	920	850	960	760	700	800	700	700	600	400	400	400	500	600
Can Tho 1	33	260	–	–	–	–	100	100	100	100	100	100	50	50	50	100	100
Saigon Steam 1	125	980	–	–	–	440†	840	800	800	600	600	500	500	500	600	750	800
Saigon Steam 2	125	980	–	–	–	–	440†	800	800	600	600	500	500	500	600	750	800
New Steam 3	220	1740	–	–	–	–	–	–	–	–	–	–	1170	1080	1180	1270	1500
New Steam 4	220	1740	–	–	–	–	–	–	–	–	–	–	–	1070	1180	1250	1490
Da Nang Steam 1	25	170	–	–	–	–	–	–	–	–	–	–	–	–	–	20	20
Da Nang Steam 2 & 3	132	1040	–	–	–	–	–	–	–	–	–	–	–	–	–	500	600
New Heavy Oil Diesel	96	590	300†	590	300	350	250	400	350	170	310	160	100	100	100	100	100
GM Diesel	100	530	220	100	15	20	20	–	–	–	–	–	–	–	–	–	–
Gas Turbines	58	200	50	30	15	20	20	30	30	30	30	30	30	30	30	30	30
Choquan	20	140	120	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Old Diesel	23	100	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total Thermal			1420	1870	1330	1990	2530	2930	2980	2300	2440	1990	2800	3780	4190	5370	6140

* Net after pumping requirements.
† One-half year operation.

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TABLE VI-9

PLAN C
INTERCONNECTED SYSTEM
PLANT PARTICIPATION AND GENERATION SCHEDULE - AVERAGE YEAR HYDRO CONDITIONS

			Gigawatthours (Four Digit Numbers Rounded to Nearest Ten)														
Hydro Plants	Rating MW	Annual Energy Cap.	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Da Nhim Restoration	160	1030	–	–	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030
Da Nhim Extension	106	750	–	–	–	–	370*	750	750	750	750	750	750	750	750	750	750
Da Quayon Stage 1	228**	1550**	–	–	–	–	–	770*	1550	1550	1550	1550	1550	1550	1550	1550	1550
Da Quayon Stage 2	206**	1200**	–	–	–	–	–	–	200†	1200	1200	1200	1200	1200	1200	1200	1200
Da Quayon 2	100	650	–	–	–	–	–	–	–	–	320*	650	650	650	650	650	650
Tri An	120	670	–	–	–	–	–	–	–	–	–	670	670	670	670	670	670
Drayling	12	50	–	–	–	–	–	–	–	–	–	50	50	50	50	50	50
La Nga Stage 1	90	520	–	–	–	–	–	–	–	–	–	–	–	–	520	520	520
Song Ba	150	870	–	–	–	–	–	–	–	–	–	–	–	–	–	870	870
Yali Falls	200	670	–	–	–	–	–	–	–	–	–	–	–	–	–	–	670
Total Hydro			–	–	1030	1030	1400	2550	3530	4530	4850	5900	5900	5900	6420	7290	7960
Load Requirement			1420	1870	2360	3020	3930	4710	5530	6230	6970	7890	8700	9680	10610	12660	14100
Less Hydro			–	–	(1030)	(1030)	(1400)	(2550)	(3530)	(4530)	(4850)	(5900)	(5900)	(5900)	(6420)	(7290)	(7960)
Thermal Requirements			1420	1870	1330	1990	2530	2160	2000	1700	2120	1990	2800	3780	4190	5370	6140
Thermal Plants																	
Thu Duc 1	33	260	230	230	150	200	100	100	100	100	100	100	100	100	100	100	50
Thu Duc 2 & 3	132	1040	460*	920	850	960	760	500	500	400	500	500	400	400	400	500	400
Can Tho 1	33	260	–	–	–	–	100	100	100	100	100	100	100	100	100	100	50
Saigon Steam 1	125	980	–	–	–	440*	840	630	550	450	610	550	400	400	450	700	550
Saigon Steam 2	125	980	–	–	–	–	440*	630	550	450	610	540	400	400	450	700	550
New Steam 3	220	1740	–	–	–	–	–	–	–	–	–	–	1200	1090	1250	1540	1050
New Steam 4	220	1740	–	–	–	–	–	–	–	–	–	–	–	1090	1240	1530	1050
Da Nang Steam 1	25	170	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Da Nang Steam 2 & 3	132	1040	–	–	–	–	–	–	–	–	–	–	–	–	–	–	200
New Steam 5	330	2600	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2040
New Heavy Oil Diesels	96	590	300*	590	300	350	250	180	180	180	180	180	180	180	180	180	180
GM Diesel	100	530	220	100	15	20	20	–	–	–	–	–	–	–	–	–	–
Gas Turbines	58	200	50	30	15	20	20	20	20	20	20	20	20	20	20	20	20
Choquan	20	140	120	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Old Diesel	23	100	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total Thermal			1420	1870	1330	1990	2530	2160	2000	1700	2120	1990	2800	3780	4190	5370	6140

* One Half year operation
† One Unit Only
** Net after pumping requirements

TABLE VI-10

PLAN A
THERMAL PLANTS
TOTAL VPC FUEL, OPERATING AND MAINTENANCE COST SUMMARY

(FOUR DIGIT NUMBERS ROUNDED TO NEAREST TEN)

	Unit	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Operating Capacity	MW*	514	514	572	697	822	822	822	822	888	954	1 174	1 394	1 394	1 394	1 394
Net Energy Generated	GWh	1 830	2 350	1 950	2 520	3 060	3 500	3 620	3 070	3 230	2 900	3 810	4 860	5 440	5 830	6 450
Fuel Cost	US$M	14 290	15 020	11 720	13 570	16 180	17 830	19 150	17 640	17 380	14 660	18 470	22 220	25 400	27 220	28 250
Cost/kWh	US Mills	7.81	6.40	6.02	5.39	5.29	5.09	5.28	5.74	5.38	5.04	4.85	4.56	4.67	4.67	4.40
O&M Cost	US$M	2 280	2 820	2 950	3 220	3 520	3 700	3 700	3 700	3 830	4 090	4 770	5 320	5 320	5 320	5 320
Total Fuel, O&M	US$M	16 570	17 840	14 670	16 790	19 700	21 530	22 850	21 340	21 210	18 750	23 240	27 540	30 720	32 540	33 570
Cost/kWh	US Mills	9.05	7.58	7.50	6.65	6.43	6.15	6.30	6.94	6.57	6.44	6.10	5.76	5.75	5.58	5.20

* Including 75 MW as an average annual operating capacity for isolated diesel plants.

TABLE VI-11

PLAN B
THERMAL PLANTS
TOTAL VPC FUEL, OPERATION AND MAINTENANCE COST SUMMARY

(FOUR DIGIT NUMBERS ROUNDED TO NEAREST TEN)

	Unit	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Total VPC	GWh	1 850	2 340	2 930	3 050	3 440	3 990	4 790	5 570	6 210	7 050	7 840	8 870	9 940	11 130	12 150
Hydro	GWh	–	–	(1 030)	(1 030)	(1 030)	(1 400)	(1 780)	(2 560)	(3 930)	(4 530)	(4 860)	(5 190)	(5 860)	(5 860)	(6 730)
Total Thermal	GWh	1 850	2 340	1 900	2 020	2 410	2 590	3 010	3 010	2 280	2 520	2 980	3 680	4 080	5 270	5 420
Fuel Cost	US$M	14 290	15 020	11 720	12 100	13 000	13 800	16 500	17 100	13 900	15 400	16 400	18 400	20 400	26 300	27 100
Fuel Cost*/kWh	US Mills	7.8	6.4	6.0	6.0	5.4	5.3	5.5	5.7	6.1	6.1	5.5	5.0	5.0	5.0	5.0
O&M Cost	US$M	2 190	2 730	2 860	2 940	3 050	3 380	3 600	3 610	3 610	3 610	3 610	3 880	4 310	5 030	5 030
Total Fuel, O&M	US$M	16 480	17 750	14 580	15 040	16 050	17 180	20 100	20 710	17 510	19 010	20 010	22 280	24 710	31 330	32 130

* Derived from Plans A and C for similar combinations of hydro-thermal plants

TABLE VI-12

PLAN C

THERMAL PLANTS

TOTAL VPC FUEL, OPERATING AND MAINTENANCE COST SUMMARY

(FOUR DIGIT NUMBERS ROUNDED TO NEAREST TEN)

	Unit	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Operating Capacity	MW*	514	514	572	697	822	822	822	822	888	954	1 174	1 394	1 394	1 394	1 624
Net Energy Generated	GWh	1 830	2 350	1 950	2 520	3 060	2 730	2 640	2 470	2 910	2 910	3 810	4 860	5 440	5 830	6 450
Fuel Cost	US$M	14 290	15 020	11 720	13 570	16 180	14 990	15 140	15 050	15 660	14 520	18 390	22 060	25 270	27 020	27 380
Cost/kWh	US Mills	7.81	6.40	6.02	5.39	5.29	5.50	5.72	6.10	5.38	4.99	4.83	4.54	4.63	4.63	4.25
O&M Cost	US$M	2 280	2 820	2 950	3 220	3 520	3 700	3 700	3 700	3 830	4 090	4 770	5 320	5 320	5 320	5 880
Total Fuel, O&M	US$M	16 570	17 840	14 670	16 790	19 700	18 690	18 840	18 750	19 490	18 610	23 160	27 380	30 590	32 340	33 260
Cost/kWh	US Mills	9.05	7.58	7.50	6.65	6.43	6.85	7.12	7.60	6.69	6.38	6.10	5.64	5.64	5.55	5.17

* Including 75 MW as an average annual operating capacity for isolated diesel plants.

TABLE VI-13

PLAN A

ESTIMATED UNFINANCED FUNDS FOR TRANSMISSION AND DISTRIBUTION *

US$M

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Major Transmission - 230 kV	0.4	1.4	10.6	14.9	11.1	2.9	3.0	3.3	4.9	8.0	9.8	9.8	7.2	3.5	1.3
Subtransmission - Saigon	–	2.3	0.7	0.1	1.5	2.2	2.6	2.1	2.3	1.3	2.7	2.5	3.3	1.7	1.8
Subtransmission - Provinces	0.1	10.6	8.2	4.3	4.5	4.4	4.2	2.1	4.0	1.5	2.8	2.8	0.9	3.0	1.7
Total Transmission	0.5	14.3	19.5	19.3	17.1	9.5	9.8	7.5	11.2	10.8	15.3	15.1	11.4	8.2	4.8
Distribution - Saigon	9.7	13.8	11.3	11.2	18.7	14.0	14.4	15.2	15.5	19.7	16.0	19.2	19.2	22.4	22.4
Distribution - Provinces	4.4	4.7	5.5	5.4	5.4	2.8	2.3	2.8	2.7	3.0	3.2	3.7	3.6	3.9	4.0
Total Dist - Saigon and Prov	14.1	18.5	16.8	16.6	24.1	16.8	16.7	18.0	18.2	22.7	19.2	22.9	22.8	26.3	26.4
Distribution - Rural **	1.3	1.3	1.7	2.2	2.2	1.6	2.5	2.6	2.9	2.9	3.1	3.3	3.4	3.7	4.4
Total Distribution	15.4	19.8	18.5	18.8	26.3	18.4	19.2	20.6	21.1	25.6	22.3	26.2	26.2	30.0	30.8
Total Trans & Dist	15.9	34.1	38.0	38.1	43.4	27.9	29.0	28.1	32.3	36.4	37.6	41.3	37.6	38.2	35.6
Foreign - 70 percent	11.1	23.9	26.6	26.7	30.4	19.5	20.3	19.7	22.6	25.5	26.3	28.9	26.3	26.7	24.9
Local - 30 percent	4.8	10.2	11.4	11.4	13.0	8.4	8.7	8.4	9.7	10.9	11.3	12.4	11.3	11.5	10.7

* Does not include funds already available.

** VPC portion only - estimated to be 30 percent of project load.

TABLE VI-13

TABLE VI-14

PLAN B

ESTIMATED UNFINANCED FUNDS FOR TRANSMISSION AND DISTRIBUTION *

US$M

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Major Transmission - 230 kV	0.4	1.2	10.5	13.9	8.8	6.0	2.5	2.0	1.4	1.9	8.0	7.5	6.2	8.5	9.2
Subtransmission - Saigon	–	2.3	0.7	0.1	1.3	1.5	2.0	1.7	1.8	1.1	2.2	2.1	2.8	1.5	1.1
Subtransmission - Provinces	0.1	10.5	8.0	3.7	3.5	3.3	3.2	1.7	3.2	1.2	2.3	2.3	0.8	2.5	1.5
Total Transmission	0.5	14.0	19.2	17.7	13.6	10.8	7.7	5.4	6.4	4.2	12.5	11.9	9.8	12.5	11.8
Distribution - Saigon	9.7	13.6	11.0	9.5	14.4	10.5	11.2	11.9	12.4	15.8	13.6	15.8	16.1	18.5	19.0
Distribution - Provinces	4.4	4.6	5.4	4.5	4.6	2.3	2.0	2.4	2.3	2.6	2.7	3.1	3.1	3.3	3.4
Total Dist - Saigon & Prov	14.1	18.2	16.4	14.0	19.0	12.8	13.2	14.3	14.7	18.4	16.3	18.9	19.2	21.8	22.4
Distribution - Rural **	1.3	1.3	1.7	1.9	1.7	1.2	1.8	2.0	2.3	2.3	2.5	2.7	2.9	3.1	3.8
Total Distribution	15.4	19.5	18.1	15.9	20.7	14.0	15.0	16.3	17.0	20.7	18.8	21.6	22.1	24.9	26.2
Total Trans & Dist	15.9	33.5	37.3	33.6	34.3	24.8	22.7	21.7	23.4	24.9	31.3	33.5	31.9	37.4	38.0
Foreign - 70 percent	11.1	23.4	26.1	23.5	24.0	17.4	15.9	15.2	16.4	17.4	21.9	23.5	22.3	26.2	26.6
Local - 30 percent	4.8	10.1	11.2	10.1	10.3	7.4	6.8	6.5	7.0	7.5	9.4	10.0	9.6	11.2	11.4

* Does not include funds already available.

** VPC Portion only - estimated to be 30 percent of projected load.

TABLE VI-14

TABLE VI-15

PLAN C
ESTIMATED UNFINANCED FUNDS FOR TRANSMISSION AND DISTRIBUTION *

US$M

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Major Transmission - 230 kV	0.4	1.4	10.6	14.9	11.1	3.9	2.7	2.6	4.9	8.0	9.8	9.8	7.2	6.8	10.0
Subtransmission - Saigon	–	2.3	0.7	0.1	1.5	2.2	2.6	2.1	2.3	1.3	2.7	2.5	3.3	1.7	1.8
Subtransmission - Provinces	0.1	10.6	8.2	4.3	4.5	4.4	4.2	2.1	4.0	1.5	2.8	2.8	0.9	3.0	1.7
Total Transmission	0.5	14.3	19.5	19.3	17.1	10.5	9.5	6.8	11.2	10.8	15.3	15.1	11.4	11.5	13.5
Distribution - Saigon	9.7	13.8	11.3	11.2	18.7	14.0	14.4	15.2	15.5	19.7	16.0	19.2	19.2	22.4	22.4
Distribution - Provinces	4.4	4.7	5.5	5.4	5.4	2.8	2.3	2.8	2.7	3.0	3.2	3.7	3.6	3.9	4.0
Total Distribution - Saigon and Provinces	14.1	18.5	16.8	16.6	24.1	16.8	16.7	18.0	18.2	22.7	19.2	22.9	22.8	26.3	26.4
Distribution Rural **	1.3	1.3	1.7	2.2	2.2	1.6	2.5	2.6	2.9	2.9	3.1	3.3	3.4	3.7	4.4
Total Distribution	15.4	19.8	18.5	18.8	26.3	18.4	19.2	20.6	21.1	25.6	22.3	26.2	26.2	30.0	30.8
Total Trans & Dist	15.9	34.1	38.0	38.1	43.4	28.9	28.7	27.4	32.3	36.4	37.6	41.3	37.6	41.5	44.3
Foreign - 70 percent	11.1	23.9	26.6	26.7	30.4	20.2	20.1	19.2	22.5	25.6	26.3	28.9	26.3	29.1	31.0
Local - 30 percent	4.8	10.2	11.4	11.4	13.0	8.7	8.6	8.2	9.8	10.8	11.3	12	11.3	12.4	13.3

* Does not include funds already available.

** VPC portion only - estimated to be 30 percent of projected load.

TABLE VI-15

TABLE VI-16

OPERATION AND MAINTENANCE COSTS
TRANSMISSION AND DISTRIBUTION

US$M

1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
							(Plan A)							
1 169	1 354	1 564	1 778	2 260	2 694	3 062	3 364	3 692	4 056	4 396	4 808	5 326	5 850	6 518
							(Plan B)							
1 169	1 352	1 557	1 741	2 118	2 335	2 587	2 804	3 025	3 285	3 513	3 820	4 200	4 571	5 032
							(Plan C)							
1 169	1 354	1 564	1 778	2 260	2 694	3 064	3 364	3 692	4 056	4 396	4 831	5 371	5 867	6 518

TABLE VI-16

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TABLE VI-17

PLAN A

SCHEDULE OF BULK POWER TRANSMISSION PROJECTS (230 kV)

Project	Total Cost	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
	US$M															
1 Da Nhim-Saigon 230-kV line restoration	1 490	400	1 090	–	–	–	–	–	–	–	–	–	–	–	–	–
2 Saigon Substation-Phu Lam 230-kV line	4 550	–	350	2 200	2 000	–	–	–	–	–	–	–	–	–	–	–
3 Saigon-Can Tho 230-kV line	5 600	–	–	2 800	2 800	–	–	–	–	–	–	–	–	–	–	–
4 Saigon Substation 230/138-kV source	1 055	–	–	–	1 055	–	–	–	–	–	–	–	–	–	–	–
5 Da Nhim Extension-Saigon 230-kV line	19 100	–	–	5 600	6 500	7 000	–	–	–	–	–	–	–	–	–	–
6 Saigon 230-kV loop	6 620	–	–	–	2 500	4 120	–	–	–	–	–	–	–	–	–	–
7 Da Quayon 1, Stage 1 tap	990	–	–	–	–	–	–	990	–	–	–	–	–	–	–	–
8 Hoc Mon 230/66-kV Substation	2 535	–	–	–	–	–	1 500	1 035	–	–	–	–	–	–	–	–
9 Nha Be 230/66-kV Substation	2 415	–	–	–	–	–	1 415	1 000	–	–	–	–	–	–	–	–
10 Da Quayon 1, Stage 2-Saigon 230-kV tap	700	–	–	–	–	–	–	–	700	–	–	–	–	–	–	–
11 Phu Lam 230/138-kV Substation	955	–	–	–	–	–	–	–	955	–	–	–	–	–	–	–
12 Tri An-Saigon 230-kV line	3 155	–	–	–	–	–	–	–	500	2 655	–	–	–	–	–	–
13 Da Quayon 2-to tap 230-kV line	1 680	–	–	–	–	–	–	–	380	1 300	–	–	–	–	–	–
14 Saigon Substation 230/138-kV reinforcement	1 560	–	–	–	–	–	–	–	–	–	–	1 560	–	–	–	–
15 La Nga-Saigon 230-kV line	10 000	–	–	–	–	–	–	–	–	–	3 000	3 000	4 000	–	–	–
16 Song Ba-Da Nang 230-kV line Song Ba-Phan Rang (Da Nhim) 230-kV line	22 400	–	–	–	–	–	–	–	700	1 000	5 000	5 000	5 000	5 700	–	–
17 Yali-Song Ba 230-kV line	6 000	–	–	–	–	–	–	–	–	–	–	200	800	1 500	3 500	–
18 La Nga-Saigon second 230-kV circuit	500*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	500*
19 Upper Se San-Saigon EHV line	750*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	750*
Total	92 055	400	1 440	10 600	14 855	11 120	2 915	3 025	3 235	4 955	8 000	9 760	9 800	7 200	3 500	1 250

* Preliminary engineering costs only

TABLE VI-17

TABLE VI-18

PLAN B
SCHEDULE OF BULK POWER TRANSMISSION PROJECTS (230 kV)

Project	Total Cost	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
	US$M															
1 Da Nhim-Saigon 230-kV line restoration	1 490	400	1 090	–	–	–	–	–	–	–	–	–	–	–	–	–
2 Saigon Substation-Phu Lam 230-kV line	4 550	–	–	2 200	2 000	350	–	–	–	–	–	–	–	–	–	–
3 Saigon-Can Tho 230-kV line	5 600	–	–	2 800	2 800	–	–	–	–	–	–	–	–	–	–	–
4 Saigon Substation 230/138-kV source	1 055	–	–	–	1 055	–	–	–	–	–	–	–	–	–	–	–
5 Da Nhim Extension-Saigon 230-kV line	19 100	–	100	5 000	6 500	5 500	2 000	–	–	–	–	–	–	–	–	–
6 Saigon 230-kV loop	6 620	–	–	500	1 500	2 620	2 000	–	–	–	–	–	–	–	–	–
7 Da Quayon 1, Stage 1 tap	990	–	–	–	–	–	–	–	990	–	–	–	–	–	–	–
8 Hoc Mon 230/66-kV Substation	2 535	–	–	–	–	–	1 000	1 535	–	–	–	–	–	–	–	–
9 Nha Be 230/66-kV Substation	2 415	–	–	–	–	415	1 000	1 000	–	–	–	–	–	–	–	–
10 Da Quayon 1, Stage 2-Saigon 230-kV tap	700	–	–	–	–	–	–	–	–	700	–	–	–	–	–	–
11 Phu Lam 230/138-kV Substation	955	–	–	–	–	–	–	–	955	–	–	–	–	–	–	–
12 Tri An-Saigon 230-kV line	3 155	–	–	–	–	–	–	–	–	–	–	655	2 500	–	–	–
13 Da Quayon 2 to tap 230-kV line	1 680	–	–	–	–	–	–	–	–	–	880	880	–	–	–	–
14 Saigon Substation 230/138-kV reinforcement	1 560	–	–	–	–	–	–	–	–	–	–	1 560	–	–	–	–
15 La Nga-Saigon 230-kV line	10 000	–	–	–	–	–	–	–	–	–	–	–	–	1 000	2 000	7 000
16 Song Ba-Da Nang-230-kV line Song Ba-Phan Rang (Da Nhim) 230-kV line	22 400	–	–	–	–	–	–	–	–	700	1 000	5 000	5 000	5 000	5 700	–
17 Yali-Song Ba 230-kV line	2 500	–	–	–	–	–	–	–	–	–	–	–	–	200	800	1 500
18 La Nga-Saigon second 230-kV circuit*	200	–	–	–	–	–	–	–	–	–	–	–	–	–	–	200
19 Upper Se San-Saigon EHV line*	500	–	–	–	–	–	–	–	–	–	–	–	–	–	–	500
Total	88 005	400	1 190	10 500	13 855	8 885	6 000	2 535	1 945	1 400	1 880	8 015	7 500	6 200	8 500	9 200

*Preliminary engineering costs only.

TABLE VI-18

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TABLE VI-19

PLAN C
SCHEDULE OF BULK POWER TRANSMISSION PROJECTS (230 kV)

Project	Total Cost	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
	US$M															
1 Da Nhim-Saigon 230-kV line restoration	1 490	400	1 090	–	–	–	–	–	–	–	–	–	–	–	–	–
2 Saigon Substation-Phu Lam 230-kV line	4 550	–	350	2 200	2 000	–	–	–	–	–	–	–	–	–	–	–
3 Saigon-Can Tho 230-kV line	5 600	–	–	2 800	2 800	–	–	–	–	–	–	–	–	–	–	–
4 Saigon Substation-230/138-kV source	1 055	–	–	–	1 055	–	–	–	–	–	–	–	–	–	–	–
5 Da Nhim Extension-Saigon 230-kV line	19 100	–	–	5 600	6 500	7 000	–	–	–	–	–	–	–	–	–	–
6 Saigon 230-kV loop	6 620	–	–	–	2 500	4 120	–	–	–	–	–	–	–	–	–	–
7 Da Quayon 1, Stage 1 tap	990	–	–	–	–	–	990	–	–	–	–	–	–	–	–	–
8 Hoc Mon 230/66-kV Substation	2 535	–	–	–	–	–	1 500	1 035	–	–	–	–	–	–	–	–
9 Nha Be 230/66-kV Substation	2 415	–	–	–	–	–	1 415	1 000	–	–	–	–	–	–	–	–
10 Da Quayon 1, Stage 2, 230-kV tap	700	–	–	–	–	–	–	700	–	–	–	–	–	–	–	–
11 Phu Lam 230/138-kV Substation	955	–	–	–	–	–	–	–	955	–	–	–	–	–	–	–
12 Tri An-Saigon 230-kV line	3 155	–	–	–	–	–	–	–	500	2 655	–	–	–	–	–	–
13 Da Quayon 2 to tap 230-kV line	1 680	–	–	–	–	–	–	–	380	1 300	–	–	–	–	–	–
14 Saigon Substation 230/138 kV reinforcement	1 560	–	–	–	–	–	–	–	–	–	–	1 560	–	–	–	–
15 La Nga-Saigon 230-kV line	10 000	–	–	–	–	–	–	–	–	–	3 000	3 000	4 000	–	–	–
16 Song Ba-Da Nang 230-kV line Song Ba-Phan Rang (Da Nhim) 230-kV line	22 400	–	–	–	–	–	–	–	700	1 000	5 000	5 000	5 000	5 700	–	–
17 Yali-Song Ba 230-kV line	6 000	–	–	–	–	–	–	–	–	–	–	200	800	1 500	3 500	–
18 La Nga-Saigon second 230-kV circuit	1 250	–	–	–	–	–	–	–	–	–	–	–	–	–	500	750
19 Upper Se San-Saigon EHV line	12 000	–	–	–	–	–	–	–	–	–	–	–	–	–	2 750	9 250
Total	104 055	400	1 440	10 600	14 855	11 120	3 905	2 735	2 535	4 955	8 000	9 760	9 800	7 200	6 750	10 000

TABLE VI-19

TABLE VI-20

SUBTRANSMISSION AND DISTRIBUTION PROJECTS – SAIGON METROPOLITAN AREA

Const Schdl	Subtransmission Line Extensions: Route	Length km	Substations: New	Substations: Add Capcty	MW Load Increase	No. New Feeders
1972	Xa-Lo-Cholon	9.5	A	Ba Queo	47	6
1973	Saigon-Xa-Lo-Go Vap-Ba Queo-Cholon	23.1	B–C	A		
	Saigon-Bien Hoa-Dong Nai (2nd circuit)	15.0	–	–	71	9
1974	–	–	–	Bien Hoa Dong Nai Xa Lo	71	9
1975	–	–	–	Ba Queo	70	9
1976	–	–	D-E	B	117	14
1977	–	–	–	Cholon-E		
	Nha Be-Sub "C"	8.0	–	–		
	Nha Be-Chanh Hung	8.2	–	–	87	10
1978	Hoc Mon Sub-Sub "B"	2.0	–	–		
	Hoc Mon Sub-Hoa Xa	8.0	–	–		
			F-G-H	D	90	13
1979	Phu Lam-Sub "J"	14.0	I-J	H	95	11
1980	–	–	K	I-J		
	Ba Queo-Sub "L" (Loop)	4.5	L		97	11
1981	–	–	–	Chanh Hung G-K	123	12
1982	–	–	M	–		
	Saigon-Dong Nai-Convert. 138 kV	15.0	–	–		
	Dong Nai-Sub "N"	4.0	N	–		
	Sub "N"-Via "H"-Bien Hoa-Saigon	21.0	–	–	100	11
1983	–	–	O-P	F-L	120	11
1984	Sub "J"-Via Hoc Mon to Sub "M"	12.0	Q-R-S	M-N-P	120	10
1985	–	–	T (Nha Be)	O-Q-S	140	12
1986			U	Saigon Dong Nai	[illegible]	12

TABLE VI-20

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TABLE VI-21

SCHEDULE OF PROVINCE CENTER TRANSFERS TO INTERCONNECTED SYSTEM

MW

Region	Center	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
I	Hue	–	–	–	–	–	–	–	–	–	–	–	–	–	–	44.4	48.7
	Da Nang	–	–	–	–	–	–	–	–	–	–	–	–	–	–	119.7	128.2
	Quang Tri	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10.0	11.5
	Hoi An	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13.8	16.5
	Quang Tin	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14.6	16.5
	Quang Ngai	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13.6	16.3
	Subtotal	–	–	–	–	–	–	–	–	–	–	–	–	–	–	216.1	237.7
II	Pleiku	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18.4
	Binh Thuan	–	–	–	–	–	–	–	–	8.6	9.6	10.6	11.6	13.0	14.4	15.9	17.4
	Dalat	–	–	8.7	11.3	13.4	17.2	20.2	20.8	21.9	24.5	28.0	29.5	32.9	36.2	39.8	42.9
	Khanh Hoa	–	–	–	–	12.1	13.6	16.2	16.8	17.1	19.9	22.1	24.1	29.2	29.8	32.9	35.7
	Qui Nhon	–	–	–	–	–	10.4	13.1	13.9	15.2	16.8	18.5	20.7	23.2	26.2	29.2	32.0
	Tuy Hoa	–	–	–	–	–	7.6	9.4	9.9	9.1	12.0	13.4	14.7	16.7	18.3	20.2	22.2
	Cam Ranh	–	–	4.0	8.5	9.6	10.5	18.5	34.9	41.8	42.4	43.9	44.8	46.1	47.3	48.7	49.9
	Phan Rang	–	–	2.0	2.7	3.4	4.0	4.9	5.1	4.5	6.2	7.0	7.7	8.7	9.7	10.7	11.8
	Kontum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9.2
	Phu Bon	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.4
	Dar Lac	–	–	–	–	–	–	–	–	–	–	12.7	13.8	15.5	17.1	18.8	20.5
	Tung Nghia (incl in Dalat)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Bao Loc	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Gia Nghia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Subtotal	–	–	14.7	22.5	37.5	63.3	82.3	101.4	115.2	131.4	156.2	166.9	185.3	199.0	216.2	262.4
III	Binh Long	–	–	–	–	–	–	–	–	–	–	–	–	–	4.6	5.2	5.9
	Phuoc Long	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3.6
	Vung Tau	–	–	–	–	5.9	6.8	7.9	8.1	8.7	9.5	10.4	11.5	12.7	14.0	15.4	16.6
	Long Khanh	–	–	–	–	–	–	–	–	–	5.3	5.9	6.8	7.7	8.6	9.6	10.8
	Long An	–	1.9	2.4	3.0	3.6	4.5	6.6	7.6	8.6	9.9	11.3	12.8	14.5	16.4	18.4	21.0
	Binh Tuy	–	–	–	–	–	–	–	–	2.3	2.7	3.0	3.3	3.7	4.2	4.7	5.2
	Tay Ninh	–	–	–	–	–	–	6.7	7.6	8.8	10.0	11.5	13.0	14.6	16.5	18.7	21.5
	Hau Nghia	–	–	–	–	–	–	3.6	4.2	4.8	5.5	6.6	7.2	8.2	9.3	10.5	12.1
	Phuoc Le	–	–	–	–	1.4	1.8	2.5	2.9	3.2	3.6	4.4	4.8	5.4	6.0	6.7	7.6
	Subtotal	–	1.9	2.4	3.0	10.9	13.1	27.3	30.4	36.4	46.5	53.1	59.4	66.8	80.1	89.2	104.3
IV	Co Cong	–	–	–	2.2	2.9	3.7	4.8	5.1	5.7	6.4	7.2	7.9	8.9	9.9	11.0	12.3
	My Tho	3.0	3.9	5.0	6.8	9.3	12.5	15.4	16.3	17.9	19.7	22.0	24.2	27.1	30.1	33.3	36.7
	Kien Hoa	–	–	–	3.8	5.0	6.6	8.4	9.1	10.1	11.2	12.7	14.0	16.1	17.8	19.8	22.1
	Kien Tung	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.5
	Kien Phong	–	–	–	–	–	–	–	3.0	3.4	3.9	4.6	5.1	5.8	6.6	7.4	8.4
	Vinh Binh	–	–	–	–	4.7	6.1	7.9	8.5	9.4	10.4	11.8	13.1	14.8	16.4	18.2	20.3
	Vinh Long	–	–	–	–	3.9	4.7	6.2	6.9	7.7	8.6	9.6	10.8	12.2	13.6	15.4	17.2
	Sa Dec	–	–	–	–	4.1	5.2	6.6	7.1	7.9	8.8	9.9	11.0	12.4	13.9	15.5	17.2
	Long Xuyen	–	–	–	–	8.9	11.0	13.8	14.7	16.4	18.1	20.3	22.5	25.4	28.0	31.4	34.7
	Chau Doc	–	–	–	–	2.8	3.5	5.0	5.7	6.5	7.4	8.5	9.4	10.8	12.2	13.7	15.6
	Rach Gia	–	–	–	–	7.1	9.1	11.1	11.8	13.0	14.4	16.0	17.7	19.9	22.1	24.5	27.1
	Can Tho	–	–	–	–	13.7	15.7	18.9	20.4	22.7	25.4	27.7	29.9	33.1	36.1	39.1	42.9
	Chuong Thien	–	–	–	–	–	–	2.8	3.1	3.5	3.9	4.3	4.8	5.5	6.2	6.9	7.9
	Ba Xuyen	–	–	–	–	5.6	7.1	8.9	9.5	10.6	11.8	12.9	14.6	16.4	18.3	20.4	22.6
	Bac Lieu	–	–	–	–	3.7	4.7	5.8	6.1	6.7	7.5	8.3	9.1	10.2	11.4	12.7	13.9
	An Xuyen	–	–	–	–	4.0	4.9	6.1	6.4	7.1	7.7	8.6	9.4	10.5	11.6	12.9	14.1
	Subtotal	3.0	3.9	5.0	12.8	58.5	94.4	121.7	133.7	148.6	165.2	184.4	203.5	229.1	254.2	282.2	315.5
	Total Provinces	3.0	6.0	21.0	40.0	107.0	171.0	232.0	265.0	300.0	343.0	393.0	430.0	481.0	533.0	808.0	920.0
	Total Saigon Metro	216.0	263.0	335.0	405.0	475.0	593.0	674.0	765.0	860.0	957.0	1 070.0	1 180.0	1 300.0	1 420.0	1 560.0	1 700.0
TOTAL INTER-CONNECTED LOAD		219.0	269.0	356.0	445.0	582.0	764.0	906.0	1 030.0	1 160.0	1 300.0	1 460.0	1 610.0	1 780.0	1 950.0	2 370.0	2 620.0

TABLE VI-21

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TABLE VI-22

PROVINCE INTERCONNECTED LOADS

Area	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	MW														
Can Tho Area															
Kien Phong	–	–	–	–	–										
Vinh Binh	–	–	–	–	4.7										
Vinh Long	–	–	–	3.4	3.9										
Sa Dec	–	–	–	3.3	4.1										
Long Xuyen	–	–	–	6.9	8.9										
Chau Doc	–	–	–	–	2.8										
Rach Gia	–	–	–	5.5	7.1	To Saigon Interconnected system									
Can Tho	–	–	–	12.0	13.7										
Chuong Thien	–	–	–	–	–										
Ba Xuyen	–	–	–	–	5.6										
Bac Lieu	–	–	–	–	3.7										
An Xuyen	–	–	–	–	4.0										
Total Interconnected	–	–	–	31.1	58.5										
Da Nang Area															
Hue	–	–	–	11.5	13.7	15.2	20.4	21.5	23.6	26.0	29.2	32.1	36.2	40.0	
Da Nang	–	–	–	32.1	44.2	59.0	60.8	64.1	70.7	79.1	85.7	92.2	102.3	109.8	To
Quang Tri	–	–	–	–	–	–	–	–	4.6	5.4	6.1	7.0	7.8	8.9	Saigon
Hoi An	–	–	–	–	3.3	4.1	5.4	6.0	6.7	7.6	8.6	7.6	12.0	12.3	inter-
Quang Tin	–	–	–	–	3.3	4.0	5.7	6.3	7.2	8.1	9.1	10.2	11.6	13.0	connected
Quang Ngai	–	–	–	–	–	–	–	5.5	6.4	7.4	8.5	9.7	11.0	9.5	system
Total Interconnected	–	–	–	43.6	64.5	82.3	92.3	103.4	119.2	133.6	147.2	158.8	180.9	193.5	

FIGURE VI-22

TABLE VI-23

SUBTRANSMISSION PROJECTS – PROVINCES
1972 – 1986

Const Schdl	Line Extension: Route	Length km	Substations: Location	Rating MVA
1971	Saigon-Long An-My Tho	60	Tan An	6.2
			My Tho	12.5
1973	Dalat-Phan Rang-Cam Ranh	140	Dalat	12.5
			Phan Rang	6.2
			Cam Ranh	12.5
	Da Nang-Hue	50	Hue	20.0
			Da Nang	50.0*
	Can Tho-Vinh Long-Sa Dec	190	Can Tho	25.0*
	Can Tho-Long Xuyen-Rach Gia		Vinh Long	6.2
			Sa Dec	6.2
			Long Xuyen	12.5
			Rach Gia	20.0
	My-Tho-Go Cong	40	Go Cong	6.2
	My Tho-Truc Giang (Kien Hoa)	14	Truc Giang	12.5
	Vinh Long-Tra Vinh (Vinh Binh)	285	Tra Vinh	6.2
	Long Xuyen-Chau Doc		Chau Doc	6.2
	Can Tho-Ba Xuyen-Bac Lieu-Ca Mau		Ba Xuyen	12.5
			Bac Lieu	6.2
			Ca Mau	6.2
1974	Da Nang-Hoi An-Tam Ky	65	Hoi An	12.5
			Tam Ky	12.5
	Cam Ranh-Nha Trang	38	Nha Trang	20.0
	Saigon-Phuoc Le-Vung Tau	97	Phuoc Le	6.2
			Vung Tau	12.5
1975	Drayling-Ban Me Thuot (Dar Lac)	17	Ban Me Thuot	12.5
	Nha Trang-Tuy Hoa-Qui Nhon	170	Tuy Hoa	12.5
			Qui Nhon	20.0
1976	Saigon-Hau Nghia-Tay Ninh	85	Trang Bang	12.5
			Tay Ninh	12.5
	Can Tho-Chuong Thien	40	Chuong Thien	12.5
	–	–	My Tho	12.5**
	–	–	Dalat	12.5**
	–	–	Da Nang II	25.0
1977	–	–	Tan An	20.0**
	–	–	Cam Ranh	25.0**
	–	–	Sa Dec	12.5**
	–	–	Long Xuyen	12.5**
	–	–	Tra Vinh	12.5**
	Sa Dec-Kien Phong (Cao Lanh)	25	Cao Lanh	12.5
	Tam Ky-Quang Ngai	--	Quang Ngai	

*Total of 2 Units **Add second transformer

FIGURE VI-23

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TABLE VI-23-CONT

SUBTRANSMISSION PROJECTS – PROVINCES
1972 – 1986

Const Schdl	Line Extension: Route	Line Extension: Length km	Substations: Location	Substations: Rating MVA
1978	Hue-Quang Tri	50	Quang Tri	12.5
	Phuoc Le-Ham Tan-Phan Thiet	115	Ham Tan	6.2
			Phan Thiet	20.0
	–	–	Hue	20.0**
1979	Bien Hoa-Long Khanh (Xuan Loc)	45	Xuan Loc	12.5
	–	–	Cam Ranh II	25.0
	–	–	Da Nang II	25.0**
1980	–	–	Phan Rang	12.5**
	–	–	Go Cong	12.5**
	Da Quayon II-Phan Thiet	60	–	–
	–	–	Chau Doc	12.5**
	–	–	Bac Lieu	12.5**
	Dalat-Dar Lac	80	Dar Lac (Existing)	–
1981	Sub I-Sub II-Can Tho	10	Can Tho II	25.0
	–	–	Truc Giang	12.5**
	–	–	Ba Xuyen	12.5**
1982	Sub I-Sub II-Dalat	5	Dalat II	12.5
	–	–	Da Nang III	30.0
	–	–	Vung Tau	12.5**
	–	–	Long Xuyen II	20.0
	Phu Lam-My Tho (Convert 138 kV)	35	My Tho II	20.0
1983	Tay Ninh-Binh Long (An Loc)	65	An Loc	12.5
	Sub I-Sub II-Hue	5	Hue II	20.0
	–	–	Tam Ky	12.5**
	–	–	Rach Gia	20.0**
1984	–	–	Hoi An	12.5**
	–	–	Phuoc Le	12.5**
1985	–	–	Tra Vinh	20.0**
	Yali-Pleiku	37	Pleiku	20.0
	Yali-Kontum	37	Kontum	12.5
1986	Pleiku-Phu Bon	80	Phu Bon	12.5
		2 000		

**Add second transformer

TABLE VI-23 – cont

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TABLE VI-24

SUMMARY COMPARISON
PLANS A, B AND C
UNFINANCED CONSTRUCTION FUNDS IN US$M*

	Plan A			Plan B			Plan C		
Year	Gen	T&D & Rural**	Total	Gen	T&D & Rural**	Total	Gen	T&D & Rural**	Total
1972	9.7	15.9	25.6	5.2	15.9	21.1	9.7	15.9	25.6
3	33.2	34.1	67.3	15.4	33.5	48.9	46.3	34.1	80.4
4	44.4	38.0	82.4	28.7	37.3	66.0	61.7	38.0	99.7
5	55.9	38.1	94.0	42.6	33.6	76.2	61.3	38.1	99.4
6	51.2	43.4	94.6	53.1	34.3	87.4	55.7	43.4	99.1
7	66.1	27.9	94.0	49.7	24.8	74.5	53.2	28.9	82.1
8	64.6	29.0	93.6	42.1	22.7	64.8	47.6	28.7	76.3
9	62.2	28.1	90.3	37.7	21.7	59.4	48.5	27.4	75.9
1980	53.7	32.3	86.0	42.6	23.4	66.0	50.9	32.3	83.2
1	35.2	36.4	71.6	43.2	24.9	68.1	46.7	36.4	83.1
2	55.0	37.6	92.6	53.6	31.3	84.9	67.9	37.6	105.5
3	53.0	41.3	94.3	57.0	33.5	90.5	58.2	41.3	99.5
4	48.2	37.6	85.8	73.2	31.9	105.1	83.2	37.6	20.8
5	72.2	38.2	110.4	57.0	37.4	94.4	72.2	41.5	13.7
6	58.7	35.6	94.3	51.0	38.0	89.0	96.2	44.3	40.5
Total US$M	763.3	513.5	1 276.8	652.1	444.2	096.3	859.3	525.5	84.7
Foreign US$M	535.3	359.4	894.7	461.9	310.9	772.8	504.8	367.9	72.7
Local US$M	228.0	154.1	382.1	190.2	133.3	323.5	254.5	157.6	12.1

* Does not include funds already available.

** VPC Portion only. Estimated to be 30 percent of projected total.

TABLE VI-24

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TABLE VI-25

PLAN A
SUMMARY OF ESTIMATED UNFINANCED CONSTRUCTION FUNDS*
US$M

Year	Generation Thrm & Hyd	& Subtrans	& Prov	Rural**	Grand Total
1972	9.7	0.5	14.1	1.3	25.6
1973	33.2	14.3	18.5	1.3	67.3
1974	44.4	19.5	16.8	1.7	82.4
1975	55.9	19.3	16.6	2.2	94.0
1976	51.2	17.1	24.1	2.2	94.6
1977	66.1	9.5	16.8	1.6	94.0
1978	64.6	9.8	16.7	2.5	93.6
1979	62.2	7.5	18.0	2.6	90.3
1980	53.7	11.2	18.2	2.9	86.0
1981	35.2	10.8	22.7	2.9	71.6
1982	55.0	15.3	19.2	3.1	92.6
1983	53.0	15.1	22.9	3.3	94.3
1984	48.2	11.4	22.8	3.4	85.8
1985	72.2	8.2	26.3	3.7	110.4
1986	58.7	4.8	26.4	4.4	94.3
Total	763.3	174.3	300.1	39.1	276.8
Foreign US$M	535.3	122.0	210.0	27.4	894.7
Domestic US$M	228.0	52.3	90.1	11.7	382.1

* Does not include funds already available.

** VPC Portion only. Estimated to be 30 percent of projected total.

TABLE VI-25

TABLE VI-26

PLAN A
ESTIMATED UNFINANCED CAPITAL COSTS OF GENERATION PROJECTS
(DOES NOT INCLUDE FUNDS ALREADY AVAILABLE)

Project	Hydro or Thermal	Total MW	Comm Date	Proj Cost	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
				US$M at 1971 Levels															
Thu Duc 2 & 3 (2 x 66 MW)	T	132	6-72	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Da Nang 1	T	25	1-74	7.0	3.0	4.0	–	–	–	–	–	–	–	–	–	–	–	–	–
Da Nhim Restoration	H	160	1-74	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Can Tho 1	T	33	6-74	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Saigon 1 (125 MW)	T	250	6-75	50.1	3.0	14.8	15.4	10.1	6.8	–	–	–	–	–	–	–	–	–	–
Saigon 2 (125 MW)	T		6-76																
Drayling 1 (8 MW)	H		1-76																
Drayling 2 (4 MW)	H	12	1-80	5.5	–	1.7	1.7	1.8	–	–	0.2	0.1	–	–	–	–	–	–	–
Da Nhim Extension	H	106	6-76	48.0	1.5	12.0	14.0	13.0	7.5	–	–	–	–	–	–	–	–	–	–
Da Quayon Stage 1	H	270	6-78	103.0	1.5	–	12.6	25.4	25.4	25.4	12.7	–	–	–	–	–	–	–	–
Da Quayon Stage 2	H	270	6-79	43.7	–	–	0.5	5.4	10.8	10.8	10.8	5.4	–	–	–	–	–	–	–
Da Nang 2 (66 MW)	T	132	6-80	27.7	–	–	–	–	–	3.2	7.2	8.2	6.1	3.0	–	–	–	–	–
Da Nang 3 (66 MW)	T		6-81																
Da Quayon 2	H	100	1-81	44.6	–	–	–	–	0.5	11.0	11.0	11.5	10.6	–	–	–	–	–	–
Tri An	H	120	1-81	50.0	0.5	0.5	–	–	–	12.0	12.0	13.0	12.0	–	–	–	–	–	–
New Steam 3 (220 MW)	T	440	1-82	72.5	–	–	–	–	–	3.0	10.0	15.0	15.0	15.0	14.5	–	–	–	–
New Steam 4 (220 MW)	T		1-83																
La Nga Stage 1	H	90	1-84	45.2	–	–	–	–	–	0.5	0.5	8.8	8.8	9.0	8.8	8.8	–	–	–
Song Ba	H	150	1-85	48.0	–	–	–	–	–	–	–	–	0.5	7.5	13.0	14.0	13.0	–	–
Yali Falls	H	200	1-86	55.0	–	–	–	–	–	–	–	–	0.5	0.5	13.5	13.5	13.5	13.5	–
New Steam 5 (330 MW)	T	660	1-87	99.0	–	–	–	–	–	–	–	–	–	–	5.0	15.0	20.0	20.0	20.0
New Steam 6 (330 MW)	T		1-88																
Remaining La Nga	H	335	1-89	164.0	–	–	–	–	–	–	–	–	–	–	–	1.5	1.5	37.0	37.0
Upper Se San	H	500	1-90	244.0	–	–	–	–	–	–	–	–	–	–	–	–	–	1.5	1.5
Diesel Replacements & Relocations	T			3.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
					9.7	33.2	44.4	55.9	51.2	66.1	64.6	62.2	53.7	35.2	55.0	53.0	48.2	72.2	58.7

New capacity through 1986 H–1 478
T–1 012
Total new capacity thru 1986 2 490 (Does not include capacity existing or under construction)

Hydro Projects–Foreign (US$M)		1.8	9.1	19.2	30.4	29.2	39.5	31.5	25.6	21.6	11.0	23.3	25.2	18.5	35.0	22.0
–Domestic (US$M at VN$275:US$1)		1.7	5.1	9.6	15.2	15.0	20.2	15.7	13.2	10.8	6.0	12.0	12.6	9.5	17.0	16.5
–Total		3.5	14.2	28.8	45.6	44.2	59.7	47.2	38.8	32.4	17.0	35.3	37.8	28.0	52.0	38.5
Thermal Projects–Foreign (US$M)		4.5	16.2	12.9	8.6	6.0	5.0	13.8	18.5	16.9	14.4	15.6	12.0	16.0	16.0	16.0
–Domestic (US$M at VN$275:US$1)		1.7	2.8	2.7	1.7	1.0	1.4	3.6	4.9	4.4	3.8	4.1	3.2	4.2	4.2	4.2
–Total		6.2	19.0	15.6	10.3	7.0	6.4	17.4	23.4	21.3	18.2	19.7	15.2	20.2	20.2	20.2
Total Project Costs through 1986 (US$M)	763.3	9.7	33.2	44.4	55.9	51.2	66.1	64.6	62.2	53.7	35.2	55.0	53.0	48.2	72.2	58.7

TABLE VI-26

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TABLE VI-27

PLAN B
SUMMARY OF
ESTIMATED UNFINANCED CONSTRUCTION FUNDS IN US$M*

Year	Generation Thrm & Hyd	Trans & Subtrans	Dist Saigon & Prov	Rural**	Grand Total
1972	5.2	0.5	14.1	1.3	21.1
1973	15.4	14.0	18.2	1.3	48.9
1974	28.7	19.2	16.4	1.7	66.0
1975	42.6	17.7	14.0	1.9	76.2
1976	53.1	13.6	19.0	1.7	87.4
1977	49.7	10.8	12.8	1.2	74.5
1978	42.1	7.7	13.2	1.8	64.8
1979	37.7	5.4	14.3	2.0	59.4
1980	42.6	6.4	14.7	2.3	66.0
1981	43.2	4.2	18.4	2.3	68.1
1982	53.6	12.5	16.3	2.5	84.9
1983	57.0	11.9	18.9	2.7	90.5
1984	73.2	9.8	19.2	2.9	105.1
1985	57.0	12.5	21.8	3.1	94.4
1986	51.0	11.8	22.4	3.8	89.0
Total	652.1	158.0	253.7	32.5	1 096.3
Foreign US$M	461.9	110.6	177.6	22.7	772.8
Domestic US$M	190.2	47.4	76.1	9.8	323.5

* Does not include funds already available.
** VPC Portion only. Estimated to be 20 percent of projected total

TABLE VI-27

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TABLE VI-28

PLAN B
ESTIMATED UNFINANCED CAPITAL COSTS OF GENERATION PROJECTS
(DOES NOT INCLUDE FUNDS ALREADY AVAILABLE)

Projects	Hydro or Thermal	Total MW	Comm Date	Proj Cost	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
				US$M at 1971 Level															
Thu Duc 2 & 3 (2 x 66 MW)	T	132	6-72	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Da Nang 1	T	25	1-74	7.0	3.0	4.0	–	–	–	–	–	–	–	–	–	–	–	–	–
Da Nhim Restoration	H	160	1-74	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Can Tho 1	T	34	6-74	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Saigon 1 (125 MW)	T	250	6-76	50.1	–	3.0	14.8	15.4	10.1	6.8	–	–	–	–	–	–	–	–	–
Saigon 2 (125 MW)	T		6-77																
Drayling 1 (8 MW)	H	12	1-76	5.5	–	1.7	1.7	1.8	–	–	0.2	0.1	–	–	–	–	–	–	–
Drayling 2 (4 MW)	H		1-80																
Da Nhim Extension	H	106	6-77	48.0	–	6.0	12.0	12.0	12.0	6.0	–	–	–	–	–	–	–	–	–
Da Quayon Stage 1	H	270	6-79	103.0	1.5	–	–	12.7	25.4	25.4	25.4	12.6	–	–	–	–	–	–	–
Da Quayon Stage 2	H	270	5-80	43.7	–	–	–	0.5	5.4	10.8	10.8	10.8	5.4	–	–	–	–	–	–
Da Nang 2 (33 MW)	T	66	1-84	18.5	–	–	–	–	–	–	–	–	2.5	4.0	4.0	4.0	4.0	–	–
Da Nang 3 (33 MW)	T		1-85																
Da Quayon 2	H	100	6-82	44.6	–	–	–	–	–	0.5	5.5	11.0	11.0	11.0	5.6	–	–	–	–
Tri An	H	120	1-84	50.0	0.5	0.5	–	–	–	–	–	–	13.0	12.0	12.0	12.0	–	–	–
New Steam 3 (220 MW)	T	440	6-83	72.5	–	–	–	–	–	–	–	3.0	10.0	15.0	15.0	13.5	16.0	–	–
New Steam 4 (220 MW)	T		1-85																
Song Ba	H	150	1-86	48.0	–	–	–	–	–	–	–	–	–	0.5	7.5	13.0	14.0	13.0	–
La Nga Stage 1	H	90	1-87	45.2	–	–	–	–	–	–	–	–	0.5	0.5	8.8	8.8	9.0	8.8	8.8
Yali Falls	H	200	1-88	55.0	–	–	–	–	–	–	–	–	–	–	0.5	0.5	13.5	13.5	13.5
New Steam 5 (330 MW)	T	660	1-88	99.0	–	–	–	–	–	–	–	–	–	–	–	5.0	15.0	20.0	20.0
New Steam 6 (330 MW)	T		1-89																
La Nga Remaining	H	335	1-90	164.0	–	–	–	–	–	–	–	–	–	–	–	–	1.5	1.5	7.0
Upper Se San	H	500	1-91	244.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.5
Diesel Replacements & Relocations	H			3.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
					5.2	15.4	28.7	42.6	53.1	49.7	42.1	37.7	42.6	43.2	53.6	57.0	73.2	57.0	51.0

New Capacity through 1986 H–1 188
T– 946

Total New Cap thru 1986 2 134 (Does not include capacity existing or under construction)

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Hydro Projects–Foreign (US$M)	1.0	5.5	9.1	18.0	28.5	28.5	27.9	23.0	19.9	16.0	22.9	22.9	25.0	24.5	20.8
–Domestic (US$M at VN$275:US$1)	1.0	2.7	4.6	9.0	14.3	14.2	14.0	11.5	10.0	8.0	11.5	11.4	13.0	12.3	10.0
–Total	2.0	8.2	13.7	27.0	42.8	42.7	41.9	34.5	29.9	24.0	34.4	34.3	38.0	36.8	30.8
Thermal Projects–Foreign (US$M)	2.5	5.7	12.0	12.5	8.0	5.6	–	2.5	10.0	15.4	15.4	18.2	28.2	16.2	16.2
–Domestic (US$M at VN$275:US$1)	0.7	1.5	3.0	3.1	2.3	1.4	0.2	0.7	2.7	3.8	3.8	4.5	7.0	4.0	4.0
–Total	3.2	7.2	15.0	15.6	10.3	7.0	0.2	3.2	12.7	19.2	19.2	22.7	35.2	20.2	20.2
Total Project Costs through 1986 (US$M) 652.1	5.2	15.4	28.7	42.6	53.1	49.7	42.1	37.7	42.6	43.2	53.6	57.0	73.2	57.0	51.0

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TABLE VI-29

PLAN C
SUMMARY – ESTIMATED UNFINANCED CONSTRUCTION FUNDS*
US$M

Year	Generation Thrm & Hy	Trans & Subtrans	Dist Saigon & Prov	Rural**	Grand Total
1972	9.7	0.5	14.1	1.3	25.6
1973	46.3	14.3	18.5	1.3	80.4
1974	61.7	19.5	16.8	1.7	99.7
1975	61.3	19.3	16.6	2.2	99.4
1976	55.7	17.1	24.1	2.2	99.1
1977	53.2	10.5	16.8	1.6	82.1
1978	47.6	9.5	16.7	2.5	76.3
1979	48.5	6.8	18.0	2.6	75.9
1980	50.9	11.2	18.2	2.9	83.2
1981	46.7	10.8	22.7	2.9	83.1
1982	67.9	15.3	19.2	3.1	105.5
1983	58.2	15.1	22.9	3.3	99.5
1984	83.2	11.4	22.8	3.4	120.8
1985	72.2	11.5	26.3	3.7	113.7
1986	96.2	13.5	26.4	4.4	140.5
Total US$M	859.3	186.3	300.1	39.1	1 384.8
Foreign US$M	600.0	130.5	210.0	27.4	967.9
Domestic US$M	259.3	55.8	90.1	11.7	416.9

* Does not include funds already available.

** VPC Portion only. Estimated to be 30 percent of projected total.

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ACCOUNTING

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TRANSMISSION AND DISTRIBUTION

SECTION VII

ACCOUNTING

ACCOUNTING PROCEDURES

In 1966, the CPM had prepared a complete report covering a classification of accounts based on the FPC Uniform System of Accounts and included instructions for changing the accounting system of EOV to the proposed classification. This proposed classification of accounts included slight numbering changes in some asset accounts as compared to the FPC classification.

Although adoption of the proposed classification was recommended by the then Director-General of EOV, nothing was done until after the merger of EOV and SPC and recommendations by several agencies pointing out that VPC could not expect to obtain financing on the world market unless or until it adopted the uniform system of accounts.

On June 1, 1970, VPC adopted the classification of accounts recommended by the CPM. It is now recommended that the numbering of the few asset accounts at variance with the FPC Uniform System of Accounts be changed to conform with the FPC system. The primary purpose of using a uniform system of accounts is that a lending institution anywhere can expect to find similar treatment of the various accounts regardless of what utility is being examined. Deviations will make it extremely difficult for an analyst to follow the accounts which will tend to reduce the credibility of the entire accounting system and have an adverse effect on credit ratings.

Other discrepancies noted include, for example, the inclusion of lubricating oil in the fuel accounts and all labor in supervision accounts.

The principal management personnel responsible for accounting and finance are well-educated, intelligent, and well-rounded individuals. Their understanding of the FPC system is somewhat limited but they have a good understanding of the basic principles involved.

One VPC employe has been attending accounting classes at the National Administration School sponsored by USAID. He has translated all of the detailed explanations of the FPC accounts into Vietnamese. He is now preparing illustrations of the use of these accounts.

It is hoped that accounting and finance management personnel will exercise their good judgment and see that the detailed accounting procedures follow explicitly the FPC Uniform System of Accounts.

The cash control and customer accounting procedures have been greatly improved. Development of a work order system is under consideration to provide cost allocation with respect to both labor and materials.

VPC has an abundance of operating detail both for the Saigon metropolitan area and for the provinces, but they lack a formal budget procedure and this information is not as useful as it might otherwise be. The provincial chiefs, who act as district or local managers, prepare monthly reports of operations for review in the Saigon office. These reports are of preliminary nature but, along with technical data, furnish basic information as to revenue and expense.

VPC has established a Management Information Service group to review the monthly data submitted by the province chiefs. This information is to be assembled on the IBM equipment by provinces, districts, and in total. When final figures are in, a final report is to be prepared in DPC, using the same breakdown of revenue and expense as is used for the VPC monthly statement. A comparison will be shown of the current month with the preceding month, and year-to-date figures will be shown compared with the corresponding period of the previous year.

Comparisons with budget figures should, of course, also be made but these will necessarily have to wait until formal month-by-month budgets have been prepared.

The Taiwan Power Company is assisting VPC in the accounting area and is scheduling an accounting class for about 40 VPC accounting employes.

It should also be mentioned that VPC's reporting of revenues has not been in accordance with the Uniform System of Accounts. Beginning in May 1969, the stated rates per kilowatthour included an amount specified as the R&R fund, determined by a separate complicated formula, and one piastre per kilowatthour specified as the equalization fund. These amounts were not included in revenue statistics. By April 1971, the R&R fund had been eliminated and the equalization fund reduced to VN$0.39 kilowatthour. Again the equalization fund part of the rate is omitted from report revenues.

In addition to the stated rates per kilowatthour, the customer also pays numerous taxes, explained

TABLE VI-30

PLAN C
ESTIMATED UNFINANCED CAPITAL COSTS OF GENERATION PROJECTS
(DOES NOT INCLUDE FUNDS ALREADY AVAILABLE)

Project	Hydro or Thermal	Total MW	Comm Date	Proj Cost	US$M at 1971 Level 1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Thu Duc 2 & 3 (2 x 66 MW)	T	132	6-72	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Da Nang 1	T	25	1-74	7.0	3.0	4.0	–	–	–	–	–	–	–	–	–	–	–	–	–
Da Nhim Restoration	H	160	1-74	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Can Tho 1	T	33	6-74	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Saigon 1 (125 MW)	T	250	6-75	50.1	3.0	14.8	15.4	10.1	6.8	–	–	–	–	–	–	–	–	–	–
Saigon 2 (125 MW)	T		6-76																
Drayling 1 (8 MW)	H	12	1-76	5.5	–	1.7	1.7	1.8	–	–	0.2	0.1	–	–	–	–	–	–	–
Drayling 2 (4 MW)	H		1-80																
Da Nhim Extension	H	106	6-76	48.0	1.5	12.0	14.0	13.0	7.5	–	–	–	–	–	–	–	–	–	–
Da Quayon Stage 1	H	270	6-77	103.0	1.5	12.6	25.4	25.4	25.4	12.7	–	–	–	–	–	–	–	–	–
Da Quayon Stage 2	H	90	6-78	43.7	–	0.5	5.0	10.3	10.3	11.1	6.5	–	–	–	–	–	–	–	–
Da Quayon Stage 2	H	180	1-79																
Da Nang 2 (66 MW)	T	132	6-80	27.7	–	–	–	–	–	3.2	7.2	8.2	6.1	3.0	–	–	–	–	–
Da Nang 3 (66 MW)	T		6-81																
Da Quayon 2	H	100	6-80	44.6	–	–	–	0.5	5.5	11.0	11.0	11.0	5.6	–	–	–	–	–	–
Tri An	H	120	1-81	50.0	0.5	0.5	–	–	–	12.0	12.0	13.0	12.0	–	–	–	–	–	–
New Steam 3 (220 MW)	T	440	1-82	72.5	–	–	–	–	–	3.0	10.0	15.0	15.0	15.0	14.5	–	–	–	–
New Steam 4 (220 MW)	T		1-83																
La Nga Stage 1	H	90	1-84	45.2	–	–	–	–	–	–	0.5	0.5	11.0	11.0	11.2	11.0	–	–	–
Song Ba	H	150	1-85	48.0	–	–	–	–	–	–	–	0.5	0.5	12.0	12.0	12.0	11.0	–	–
Yali Falls	H	200	1-86	55.0	–	–	–	–	–	–	–	–	0.5	0.5	13.5	13.5	13.5	13.5	–
New Steam 5 (330 MW)	T	660	1-86	99.0	–	–	–	–	–	–	–	–	–	5.0	15.0	20.0	20.0	20.0	19.0
New Steam 6 (330 MW)	T		1-87																
La Nga & Da Rgna	H	335	1-88	156.5	–	–	–	–	–	–	–	–	–	–	1.5	1.5	37.0	37.0	37.0
Upper Se San	H	500	1-89	244.0	–	–	–	–	–	–	–	–	–	–	–	–	1.5	1.5	40.0
Diesel Replacements & Relocations	T			3.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
					9.7	46.3	61.7	61.3	55.7	53.2	47.6	48.5	50.9	46.7	67.9	58.2	83.2	72.2	96.2

New Capacity through 1986 H–1 478
T–1 342

Total New Capacity thru 1986 2 820 (Does not include capacity existing or under construction)

		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Hydro Projects–Foreign (US$M)		1.8	18.2	30.7	34.0	32.5	31.2	20.2	16.8	19.7	15.7	25.5	25.3	42.0	34.7	48.7
–Domestic (US$M at VN$275:US$1)		1.7	9.1	15.4	17.0	16.2	15.6	10.0	8.3	9.9	7.8	12.7	12.7	21.0	17.3	28.3
–Total		3.5	27.3	46.1	51.0	48.7	46.8	30.2	25.1	29.6	23.5	38.2	38.0	63.0	52.0	77.0
Thermal Projects–Foreign (US$M)		4.5	16.2	12.9	8.6	6.0	5.0	13.8	18.5	16.9	18.4	23.8	16.0	16.0	16.0	15.2
–Domestic (US$M at VN$275:US$1)		1.7	2.8	2.7	1.7	1.0	1.4	3.6	4.9	4.4	4.8	5.9	4.2	4.2	4.2	4.0
–Total		6.2	19.0	15.6	10.3	7.0	6.4	17.4	23.4	21.3	23.2	29.7	20.2	20.2	20.2	19.2
Total Project Costs through 1986 (US$M)	859.3	9.7	46.3	61.7	61.3	55.7	53.2	47.6	48.5	50.9	46.7	67.9	58.2	83.2	72.2	96.2

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in detail in Section IX. Under proper accounting procedures, all amounts billed to the customer would be reported as gross revenues with these taxes offset by entries to accrued taxes.

Another deficiency in proper accounting procedures occurs in VPC's present billing practices. Beginning in May 1969, the rate for air-conditioning was made the same as the rate for lighting. Previously, air-conditioning was billed at the low-voltage power rate – a lower rate – and consequently separately metered. However, although the rates for these two services are identical, including the same taxes, VPC is still reading the two separate meters and rendering two separate bills to customers having both lighting and air-conditioning service. As more fully covered in Section IX, this deficiency must be corrected before VPC can accumulate the necessary proper bill analyses required for proper rate design.

In order for VPC to prepare itself for later financing on the world market of the proposed large-scale construction program included in this report, it is imperative that VPC eliminate the deficiencies mentioned above and put its accounting procedures in complete accord with the FPC Uniform System of Accounts.

Also, as detailed in Section IX, Rates, VPC must initiate the collection of data for necessary cost-of-service studies.

Property Records

VPC utility property as of December 31, 1970, as recorded, is shown in Table VII–1. These plant records are maintained by DPC with proper coding for plant classification, location, and depreciation rate.

The proper account numbers are being used but only a complete audit would determine accuracy and, since a work order system is not being used, this would be extremely difficult.

However, the plant totals shown on Table VII–1 include considerable adjustments in connection with the merger of EOV and SPC. These adjustments covered the inclusion of:

a. The value of USAID donations of machinery and diesel generators to EOV previously not included in property records.

b. The value of plant constructed with R&R funds previously depreciated to zero.

c. Re-evaluation of property covered by loans from the EXIM Bank and the US Development Loan Fund (DLF) to the up-dated exchange rate (VN$275/US$1).

It is believed that a more factual statement of plant in service, required for proper rate design, would be obtained by revaluing all plant in service to the up-dated exchange rate. However, such a re-evaluation would be a very large task and, because of the large construction program included in this study, the omission of such re-evaluation can have only a minimal effect on the financial programs proposed.

TABLE VII–1

VPC UTILITY PROPERTY DECEMBER 31, 1970

	Book VN$	Per-cent	Less Depreciation VN$	Per-cent	Net VN$	Per-cent
Hydro	2 444 890 707	13.3	885 995 659	19.2	1 558 895 048	11.4
Steam	1 665 229 898	9.1	490 146 621	10.6	1 175 083 277	8.6
Diesel-Saigon-Cholon	5 170 832 124	28.3	854 537 154	18.6	4 316 294 970	31.6
Diesel-Provinces	1 479 769 528	8.1	259 051 144	5.6	1 220 718 384	8.9
Transmission	2 355 976 598	12.9	605 747 351	13.1	1 750 229 247	12.8
Distribution	2 729 327 764	14.9	628 791 168	13.6	2 100 536 596	1[illegible] 4
Other	2 445 577 574	13.4	888 345 667	19.3	1 557 231 907	11.3
	18 291 604 193	100.0	4 612 614 764	100.0	13 678 989 429	100.0

TABLE VII–1

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A work order system is recommended for use in recording plant to be installed. If this is done, future plant records will be accurate; the old plant will be fully depreciated over the next ten years; and in the meantime, such old plant as is not depreciated will soon be dwarfed by the large additions made year by year for new plant.

Subject to the above, the present records support the plant accounts as shown in the FPC classifications. If the work order system is adopted and followed, future records will be obtained to fully support that classification.

DEPRECIATION PRACTICE

Depreciation accounting is designed to distribute the cost or other basic value of tangible capital assets over the estimated useful life by unit or groups of units in a systematic and logical manner.

There is no exact method. There are several logical and systematic methods, such as straight line, sinking fund, compound interest, diminishing balance, or quasi-trust fund reserve. Whatever method is used, experience has generally shown that about 80 percent of retirements take place not because the units are fully depreciated but because they have become inadequate or obsolete.

Nevertheless, it is recognized that gross revenue must be reduced for depreciation on some basis to arrive at a more realistic net. In the US, depreciation rates, like electric service rates, are subject to regulation by a public utility commission and, over the years, fairly uniform schedules have been established.

VPC and its predecessor companies have had a variety of depreciation practices.

Under the concession granted to CEE in1932, depreciation was computed on each major item of equipment. Two complicated but logical and systematic methods were used. Two methods were logical since the French operated under two separate sets of conditions. One was the "Domaine Concede" where the French owned and operated the distribution system which would revert to GVN at no cost at the end of the franchise. The other, "Domaine Prive", was the operation and ownership of the production facilities. For the "Domaine Concede", they were designed to provide normal depreciation plus financial amortization of property added during the life of the franchise. For the "Domaine Prive", they were designed to provide normal depreciation plus one-third financial amortization. Financial amortization at one-third of property added during the life of the franchise was to compensate for the loss which might be incurred when CEE disposed of these assets at the end of the franchise.

In December of 1970, a new schedule of straight-line depreciation rates was established. These rates were extremely high and averaged about ten percent per year. Revised rates were established October 12, 1971, and are shown in Table VII–2. Suggested rates for consideration for new plant are shown in Table VII–3.

As mentioned in Section VIII, the depreciation expense included in the operating statements in that section is the sum of depreciation charges at the present rate on "old" plant, i.e., plant installed prior to December 31, 1971, and depreciation charges of 3.5 percent on "new" plant, i.e., plant installed after January 1, 1972. It is recommended that VPC adopt the suggested rates for all plant installed after January 1, 1972.

INTEREST DURING CONSTRUCTION

It is the present practice of VPC to charge interest during construction to operations. This is acceptable, at least for the present, since such charges do not produce funds for the cash flow. Charging this interest to expense reduces the income tax liability. The practice, in the US, of charging interest during construction to expense, has varied from time to time. However, it is the more usual practice to charge interest during construction to the capital cost of the project.

In preparing the 15-year forecast, all interest is shown as being charged to expense because of the reasons stated above. However, it is recommended that VPC review this matter from time to time, taking into account the resulting effect on net income, income taxes, and the rate base. It may, at some future date, be desirable to capitalize interest during construction. Some additional considerations on this matter follow.

The true cost of plant includes the interest cost of money used for construction during the construction period. On a fixed-price contract, the contractor includes this interest as a part of his costs, and if the interim payments are paid by the company, the interest cost of that money is also a part of the cost of the property constructed. When construction work is performed by the company itself, it may use borrowed money or retained earnings. If borrowed money is used, the interest cost applicable to construction is at the rate charged by the lender. If company money is used, the interest cost is at the rate the company is allowed to earn on its rate base.

TABLE VII–2

Vietnam Power Company
List of Years of Depreciation of Fixed Assets
October 12, 1971

Account		Depreciation Years
	INTANGIBLE PLANT	
301	Organization	9
302	Franchises and consents	0
303	Miscellaneous intangible plant	3
	PRODUCTION PLANT – (Steam)	
310	Land and land rights	0
311	Structures and improvements	20
312	Boiler plant equipment	20
313	Engine and engine-driven generators	10
314	Turbogenerator units	20
315	Accessory electric equipment	10
316	Miscellaneous power plant equipment	10
	PRODUCTION PLANT – (Diesel)	
320	Land and land rights	0
321	Structures and improvements	10
322	Fuel tanks	10
323	Prime movers	10
324	Alternators	10
325	Accessory electric equipment	10
326	Miscellaneous power plant equipment	10
	HYDRAULIC PRODUCTION	
330	Land and land rights	0
331	Structures and improvements	20
332	Reservoirs, dams, and waterways	20
333	Water wheels, turbines, and generators	15
334	Accessory electric equipment	10
335	Miscellaneous power plant equipment	10
336	Roads, railroads, and bridges	15
	OTHER PRODUCTION (Gas Turbine Plant)	
340	Land and land rights	0
341	Structures and improvements	15
342	Fuel holders, producers, and accessories	10
344	Generators	15
345	Accessory electric equipment	10
346	Miscellaneous power plant equipment	10
	TRANSMISSION PLANT	
350	Land and land rights	0
351	Clearing land and rights of way	0
352	Structures and improvements	20
353	Station and improvement	15
354	Towers and fixtures	15
355	Poles and fixtures	10
356	Overhead conductors and devices	15
357	Underground conduit	15
358	Underground conductors and devices	10
359	Roads and trails (Access road)	10
	DISTRIBUTION PLANT	
360	Land and land rights	0
361	Structures and improvements	20
362	Station equipment	10
363	Storage battery equipment	5
364	Poles, towers, fixtures	10
365	Overhead conductors and devices	15
366	Underground conduit	15
367	Underground cables	10
368	Line transformers	10
369	Installations on customers premises	5
370	Meters	25
	GENERAL PLANT	
389	Land and land rights	0
390	Structures and improvements	20
391	Office furniture and equipment	15
392	Transportation equipment	10
393	Stores equipment	15
394	Tools, shop, and garage equipment	10
397	Communication equipment	10
398	Miscellaneous equipment	10

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TABLE VII–3

Years of Depreciation Recommended For Consideration For New Plant

Depreciable Electric Property	Years
HYDRO PRODUCTION	
Structure and improvements	25
Reservoirs, dams and waterways	50
Water wheels, turbines and generators	40
Accessory electric equipment	25
Roads, railroads and bridges	50
Miscellaneous power plant equipment	42
STEAM PRODUCTION	
Structures and improvements	45
Boiler plant equipment	45
Turbogenerator units	45
Accessory electric equipment	40
Miscellaneous power plant equipment	40
INTERNAL COMBUSTION ENGINE PRODUCTION	
Structures and improvements	10
Fuel holders, producers, and accessories	10
Prime movers	10
Accessory electric equipment	10
Miscellaneous power plant equipment	10
Generators	10
TRANSMISSION PLANT	
Clearing land and rights of way	60
Structures and improvements	45
Station equipment	50
Towers and fixtures	50
Poles and Fixtures	40
Overhead conductors and devices	50
DISTRIBUTION PLANT	
Structure and improvements	45
Station equipment	50
Poles, towers, and fixtures	30
Overhead conductors and devices	45
Underground conduit	50
Underground conductors and devices	40
Line transformers	35
Services	25
Meters	30
Installations on customer premises	25
Street light and signal systems	25
GENERAL PLANT	
Structures and improvements	30
Office furniture and equipment	30
Transportation equipment	7
Stores equipment	25
Tools, shop, and garage equipment	35
Laboratory equipment	25
Power-operated equipment	10
Communications equipment	25
Miscellaneous equipment	25
Other tangible property	40

Where it is impractical to trace dollars, as it frequently is when both borrowed funds and company funds are used, it is advisable to use a composite rate. This composite rate is arrived at by dividing the sum of the total cost of money borrowed and the computed cost of company funds used by the sum of the total money borrowed and the total of company funds used for construction.

The interest charged to construction should be computed each month so that monthly earnings will be reflected on a true basis and the plant account will reflect the true cost of plant.

Interest charged to operations by VPC during the first four months of 1971 amounted to VN$105 716 931. On an annual basis the corresponding amount would be VN$317 150 793 or US$1 153 231 at the rate of VN$275/US$1.

At the beginning of the year, VPC's books showed construction work in progress totaling VN$550 335 602. Interest on this sum at an assumed composite rate of six percent amounts to VN$33 020 136 or US$120 000 at the official rate of VN$275/US$1.

Therefore, if this amount had been added to construction costs, the interest chargeable to operations would be reduced from VN$317 150 793 to VN$284 130 657, a reduction of a little over ten percent.

As construction work in progress increases, the interest on the borrowings for construction will become of increasing importance. Since many projects will be separately financed and at different rates of interest, it would be possible to charge interest for those projects at the loan rates applicable to the individual project. This method would become cumbersome as time goes on and would become impractical when funds are borrowed for general corporate purposes instead of for specific projects.

Since interest rates will fluctuate from time to time, and since composite or individual rates require considerable accounting work, it is recommended that the company use an arbitrary rate. The rate used should approximate the composite rate in effect at the beginning of the year. The arbitrary rate should be reviewed each year and, if deemed advisable, changed.

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FINANCIAL MANAGEMENT

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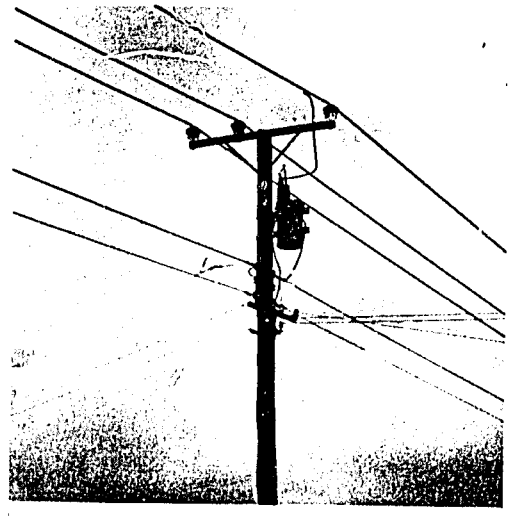

NEW 15-kV DISTRIBUTION

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SECTION VIII

FINANCIAL MANAGEMENT

GENERAL

In the US, the financing of expansion programs of privately owned utilities is accomplished, in general, partly through the use of internal funds and partly through external funds. The internal funds come principally from the annual provision for depreciation and, to a lesser extent, from retained net earnings, i.e., the portion of net earnings not paid out to stockholders but retained for general corporate purposes. Taken together, such internal funds usually provide a substantial part of the total amount needed for the expansion program. The amount of such funds would depend on established policy with regard to depreciation, the profitability of the company's operations, and on company policy with regard to the percentage of net income that is paid out to the company's owners, i.e., the shareholders. The proportion of the total amount of funds required that might come from internal sources would depend also on the size of the planned expansion program. For example, if the annual expansion were of the order of seven percent, the internal sources might provide something like half of the required capital.

The additional capital required over and above what can be supplied from internal sources must be obtained from external sources. In most cases, this would involve the sale to the public of securities, such as mortgage bonds, preferred stock, or common stock. In some cases, it might involve a short-term loan from a bank or other such institution. However, the common practice is that short-term loans are usually paid off when more permanent financing can be arranged.

A fundamental aspect of US practice is that the capital structure keeps growing year after year. This is true of both the equity and debt portions of the structure. Although debt capital is usually obtained for a fixed period of years, it is normally retired when it matures through the sale of another series of bonds, i.e., the practice of amortizing the loan during its term is unusual. Thus, new capital that is needed year after year for the financing of expansion becomes, in effect, a permanent part of the capital invested in the company.

As will be apparent, the consumer under US practice actually pays for a substantial portion of the total cost of new facilities that is added each year. The consumer does this by bearing, in the price he pays for service, the costs of depreciation, i.e., the actual cost of plant consumed in providing service to him plus the net profit on the investment in such plant. Now, if the depreciation, as charged, has a reasonable relationship to the loss in value of the plant needed to serve him and if the total net profit taken on such plant is reasonable, the consumer is not unfairly burdened and, in such circumstances, the US courts have held that the overall results are equitable to all parties.

This method of financing is ultimately recommended in the financial program that follows.

FINANCIAL PROGRAM

The financing of VPC is governed by four conditions:

1. Until there is free convertibility of internally generated funds and marketability for VPC securities, borrowing of funds is limited to project financing. Such borrowing will approximate 70 percent of project costs.
2. GVN is the only source of additional equity funds.
3. Bank borrowing is at prohibitive rates and should not be considered except for serious emergencies.
4. No matter how much money is generated internally by VPC, it can only be used internationally when converted by GVN into international funds.

The projected financing of the proposed construction programs is governed by these facts. The proposed utility-type financing included in this study is broken into two periods, 1972–1979 and 1980–1986. From 1972 to 1979, external funds required are obtained from project financing and from sale of stock to GVN.

Beginning in 1980, it is assumed that VPC will have free convertibility of internally generated funds, and external funds required will be obtained through the sale of bonds which has been estimated to be approximately 40 percent of the total funds required.

In setting up this program, US dollars rather than Vietnamese piastres have been used in order to have a uniform basis for comparative purposes.

An exchange rate of VN$275/US$1 was used where necessary to reflect piastre amounts in US dollars.

The primary financial problem involved in building an adequate power system in Vietnam relates to the large amounts of foreign exchange that will be needed. In aggregate, the plan developed will increase the national power supply by about nine times from 1971 to 1987. It has been estimated that this expansion, in addition to foreign exchange obtained from project financing, will require foreign exchange increasing from US$21.9 million in 1972 to US$109.9 million in 1986, or a total of US$903.9 million for Plan A for the 15-year period as shown on Table VIII-8. However, considering the similar situations initially facing Taiwan and Korea and their subsequent success, it is entirely possible that Vietnam will also surmount its problem. It must be pointed out that considering GVN's presently limited amount of foreign exchange, it appears that GVN will need a considerable amount of assistance in the form of grants of foreign funds that can be loaned to VPC with interest and principal repayments made in domestic funds.

The general objective in the financing programs shown in the report is to put VPC on a footing similar to other electric utilities. This can only be accomplished after Vietnam has free convertibility of its currency. Another important goal was that VPC should have a reasonable capitalization ratio of about 60 percent debt and 40 percent equity. Under the proposed financing plan, VPC reaches this ratio in 1983 or 1984 depending on the construction plan and could presumably pay dividends beginning at that time and maintain the 60–40 debt-equity ratio. However, doing so would increase bond requirements and reduce allowable net income during this period. We have, therefore, assumed that VPC would not pay dividends but would permit the equity to grow through retained earnings.

The proposed financial program, by years, is shown on Tables VIII– 1 to VIII– 6. Table VIII– 1 gives the plant, capital, and operating statement for Plan A; and Table VIII– 2 tabulates the cash flow and convertibility requirements for the same plan. Similarly, Tables VIII– 3 and VIII– 4 include the information for Plan B and Tables VIII– 5 and VIII– 6 cover Plan C.

These tables are abbreviated and simplified financial statements for VPC for the years indicated. They are based on the reported financial statements of VPC for the year 1970 (and estimated financial statements for the year 1971) suitably modified to reflect the financial effects of the very large building programs described in Section VI.

The proposed plan assumed that VPC will be permitted net earnings equal to ten percent of the equity capital; that project borrowings will carry six percent interest with a 25-year term and a five-year repayment grace period or 20-year payback period; that permanent financing with bonds beginning in 1980 would cost six percent; and that GVN, as the only stockholder, would supply the needed equity and furnish the necessary foreign exchange by conversion of VPC internally generated funds.

The notes to Tables VIII– 1 and VIII– 2 explain what the various figures represent and how they were obtained. These notes are also applicable to Tables VIII– 3, VIII– 4, VIII– 5, and VIII– 6.

The following table shows a summarization of the information on Tables VIII– 2, VIII– 4, and VIII– 6 for the 15-year period which covers the source of funds: project financing (including financing covered by previous commitments), net income, depreciation, sale of stock and bonds, and the total expenditures in US$ million for the three construction plans.

	US$ Million		
Source of Funds	Plan A	Plan B	Plan C
Project Financing	480.1	372.6	459.2
Net Income	415.6	354.6	439.6
Depreciation	373.2	320.3	381.0
Sale of Stock to GVN	81.3	58.6	86.4
Bonds	339.4	346.7	443.0
Total Expenditures	1 689.6	1 452.8	1 809.2

The following table summarizes the foreign exchange requirements (exclusive of project financing), the amounts of foreign exchange covered by sale of stock to GVN, and the remaining balance which must be supplied by GVN conversion of VPC internally generated funds for the period 1972–1979 (until assumed free convertibility in 1980.)

	US$ Million		
	Plan A	Plan B	Plan C
Foreign Exchange	302.2	262.5	300.0
Sale of Stock to GVN	(81.3)	(58.6)	(86.4)
GVN Conversion	220.9	203.9	213.6

As mentioned previously, the only way that VPC can economically finance the proposed construction programs includes the sale of additional stock to GVN. In connection with this

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proposed equity financing, it is important to note that the VPC book entries as of December 31, 1970, show a capital investment of US$2.5 million compared to a total equity of US$46.0 million. The difference of US$43.5 million is largely made up of plant donated by the US, Japanese war reparation funds, and R&R funds received from customers. In other words, GVN has acquired an equity of US$46.0 million with an investment of only US$2.5 million. It appears obvious that GVN should be willing to invest an additional US$81.3 million (Plan A) which, with retention of all net earnings, results in an equity of US$546.6 million by the end of 1986

For comparative purposes, we have also included a financing program for Plan A where GVN does not purchase any additional stock, the required external funds being borrowed at a commercial rate of 18 percent with no subsidy from GVN. The results of this analysis are shown on Tables VIII– 7 and VIII– 8. It should be noted that the foreign exchange convertibility requirements for the 1972–1979 period remain the same as shown on Table VIII– 2. In other words, GVN must provide the same total of foreign exchange regardless of the method of financing. (The notes to Tables VIII– 1 and VIII– 2 are also applicable to Tables VIII– 7 and VIII– 8 except for Lines 8, 9, and 16, on Table VIII– 7; and Lines 6, 13, and 14, on Table VIII– 8.)

Another comparison worth noting is "times interest earned". Financial analysts generally require that net operating income be at least twice as much as interest payments required. Table VIII– 1 shows that, with GVN purchasing stock, net operating income is 2.15 times the interest requirement. Table VIII– 7 shows net operating income of only 1.27 times interest charges. Financial analysts would rate a company in this position as a very poor credit risk. Note that Table VIII– 8 also includes foreign exchange convertibility requirements for the period 1980–1986, which gives the picture if free convertibility does not occur beginning in 1980.

An objective in the financing program was that VPC should have a reasonable debt-equity ratio in the neighborhood of 60–40. Although a few US utilities with exceptional credit ratings approach a 65–35 debt-equity ratio, their bond ratings are not quite as good as similar utilities maintaining a 60–40 ratio. As shown on Table VIII– 7, if GVN does not purchase additional stock, VPC's debt-equity ratio would exceed 80–20 for most of the 15-year period. It is, therefore, obvious that GVN must provide the necessary additional equity through purchase of stock if VPC is going to be able to finance the proposed construction program.

Another comparison is worth noting. Table VIII– 1 indicates an average rate of return for the 15-year period of 8.30 percent. Table VIII– 7 gives an average rate of return of 9.53 percent. In other words, the rate of return must be over one percent higher in order to cover the increased interest costs on this plan of financing.

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TABLE VIII–1

PLAN A
PROPOSED UTILITY–TYPE FINANCING
PLANT, CAPITAL, AND OPERATING STATEMENT

US$ Million (VN$275/US$1)

LINE	DESCRIPTION	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	Gross Plant in Service	90.5	148.1	208.3	253.2	318.9	452.4	479.9	617.2	691.5	834.3	914.4	908.4	999.1	1 103.5	1 203.8	1 291.6
2	Depreciation Reserve	(23.0)	(29.4)	(37.8)	(48.1)	(60.1)	(75.7)	(94.0)	(115.1)	(139.8)	(166.6)	(198.3)	(155.6)	(188.0)	(223.6)	(262.9)	(305.7)
3	Net Plant in Service	67.5	118.7	170.5	205.1	258.8	376.7	385.9	502.1	551.7	667.7	716.1	752.8	811.1	879.9	940.9	985.9
4	Matrl, Supp & Wrk Cap	9.1	14.8	20.8	25.3	31.9	45.2	48.0	61.7	69.2	83.4	91.4	90.8	99.9	110.4	120.4	129.2
5	Rate Base	76.6	133.5	191.3	230.4	290.7	421.9	433.9	563.8	620.9	751.1	807.5	843.6	911.0	990.3	1 061.3	1 115.1
6	Const Work in Progress	32.0	19.6	49.7	90.6	121.2	84.6	153.4	111.9	130.0	75.1	68.0	94.8	102.2	87.0	101.5	111.8
7	Total Assets	108.6	153.1	241.0	321.0	411.9	506.5	587.3	675.7	750.9	826.2	875.5	938.4	1 013.2	1 077.3	1 162.8	1 226.9
8	Equity Capital	49.7	63.5	90.5	116.8	148.4	183.0	204.9	235.3	261.4	290.4	322.7	358.6	398.4	442.7	491.9	546.6
9	Debt Capital	58.9	89.6	150.5	204.2	263.5	323.5	382.4	440.4	489.5	535.8	552.8	579.8	614.8	634.6	670.9	680.3
10	Total Liabilities	108.6	153.1	241.0	321.0	411.9	506.5	587.3	675.7	750.9	826.2	875.5	938.4	1 013.2	1 077.3	1 162.8	1 226.9
11	Average Rate / kWh		3.42	3.17	2.75	2.69	2.54	2.44	2.38	2.29	2.24	2.13	2.09	2.03	2.02	1.97	1.94
12	Gross Revenue		48.49	59.19	65.72	79.09	96.85	111.10	126.11	138.35	149.92	162.35	175.58	190.14	208.55	227.15	245.31
13	Less O & M		(22.86)	(24.55)	(21.84)	(24.43)	(28.43)	(31.92)	(34.94)	(35.38)	(30.77)	(36.58)	(42.54)	(48.66)	(54.27)	(58.75)	(62.59)
14	Depreciation		(7.94)	(9.86)	(11.79)	(13.48)	(17.08)	(19.84)	(22.57)	(26.24)	(28.29)	(33.23)	(32.83)	(32.42)	(35.57)	(39.31)	(42.80)
15	Taxes, Excl Income		(4.68)	(5.71)	(6.34)	(7.63)	(9.35)	(10.72)	(12.17)	(13.35)	(14.49)	(15.67)	(16.94)	(18.35)	(20.13)	(21.92)	(23.67)
16	Interest (Domestic)		(2.08)	(2.34)	(2.26)	(2.11)	(1.96)	(1.82)	(1.67)	(1.52)	(1.37)	(1.22)	(1.06)	(0.93)	(0.78)	(0.63)	(0.51)
17	Interest (Foreign)		(2.01)	(4.02)	(7.08)	(10.60)	(14.33)	(18.02)	(21.71)	(25.15)	(28.24)	(30.33)	(31.82)	(33.83)	(35.63)	(37.45)	(38.97)
18	Taxable Income		8.92	12.71	16.41	20.84	25.79	28.78	33.05	36.71	40.78	45.32	50.37	55.95	62.17	69.09	76.77
19	Income Tax		(2.57)	(3.66)	(4.73)	(6.00)	(7.40)	(8.29)	(9.52)	(10.57)	(11.74)	(13.05)	(14.51)	(16.11)	(17.90)	(19.90)	(22.11)
20	Net Income		6.35	9.05	11.68	14.84	18.30	20.49	23.53	26.14	29.04	32.27	35.86	39.84	44.27	49.19	54.66
21	Debt–Equity Ratio																
22	Debt – Percent		58.5	62.4	63.6	64.0	63.9	65.1	65.2	65.2	64.8	63.0	61.8	60.6	58.9	57.7	55.4
23	Equity–Percent		41.5	37.6	36.4	36.0	36.1	34.9	34.8	34.8	35.2	37.0	38.2	39.4	41.1	42.3	44.6
24	Net Operating Income		10.44	15.41	21.02	27.55	34.59	40.33	46.91	52.81	58.65	63.82	68.76	74.60	80.68	87.27	94.14
25	Rate of Return - Percent		7.82	8.06	9.12	9.48	8.20	9.29	8.32	8.51	7.81	7.90	8.15	8.19	8.15	8.22	8.44

NOTES:

Line 1 *GROSS PLANT IN SERVICE*

All costs of such plant have been accumulated under this caption. The total, therefore, includes the value of all old plant still in service plus that of all new plant placed in service during the year indicated. The new plant added includes the proposed construction described in Section VI as well as that plant for which financing had been arranged before the end of 1971. See also comments under the caption, "Construction Work in Progress". Interest during construction is not included here but is included on Lines 16 and 17. (See comments on Interest During Construction, Section VII.)

Costs are included for general plant, i.e., office buildings and equipment, warehouses, shops, transportation and communication equipment, etc. It is assumed that additional general plant will amount to four percent of total additional plant and that the foreign exchange required will be one-half of the total. The estimated totals of general plant additions are included on Line 12, Table VIII–2.

It should be noted that, in certain cases, new plant has been scheduled for completion at the year end. In such cases, the cost of the completed plant has been included in the total cost of plant in service for that year.

Line 1 *GROSS PLANT IN SERVICE— Cont*

As an average, it is estimated that 70 percent of the cost of plant added (other than general plant) will require foreign exchange.

Line 2 *DEPRECIATION RESERVE*

The amounts shown represent an estimate of the total depreciation reserve at the end of the year indicated. These amounts apply, of course, to all plant owned by VPC at the end of the year including both the "old" plant, i.e., that plant in service at the end of 1971, and "new" plant, i.e., that completed and placed in service in 1972 or later.

Old plant has been depreciated at approximately the same rate (based on plant in service at the beginning of the year--previous year end) as is currently being used by VPC. A "book" entry has been made for the retirement of VN$1.5 million of such plant every year beginning in 1972. The effect of this provision is to reduce the remaining balance for plant in service and depreciation reserve by VN$1.5 million each year. Following this regime, the depreciation reserve for the old plant is approximately equal to the book balance for remaining old plant in service in the year 1982. Hence, all the old plant is retired in that year. It must be emphasized that this is merely a bookkeeping entry to reflect the fact that total value of the assets concerned has been recovered through the annual provision for depreciation. Actually, some of the old plant will probably be in useful service for many additional years.

In the case of new plant, the depreciation reserve has been accumulated each year on the cumulative value of all new plant placed in service. In the first year of operation, account has been taken of the time when the plant involved was placed in service. If the in-service date was midyear, only one-half year's depreciation is provided for the initial year; if the in-service date is year end, no depreciation is provided for the year in which the plant was placed in service. A uniform depreciation allowance of 3.5 percent per year has been used for all new plant.

One special case concerns the repair to the transmission line from Da Nhim hydro plant to Saigon. Although the cost of repairs has been included in the capital requirements, no provision has been made for any depreciation on this outlay because the full cost of the original line is already included in the costs and reserves for "old" plant.

No specific provision has been made for replacement of "new" plant even though a certain amount of such plant will undoubtedly have to be replaced each year due to storm damage and other causes. However, it is expected that the cost of such replacements will be very small in relation to the total amounts being considered.

Line 3 *NET PLANT IN SERVICE*

This is the difference between cost of plant in service and the amount of the depreciation reserve. In effect, it is the unrecovered cost of plant in service.

Line 4 *MATERIALS, SUPPLIES, AND WORKING CAPITAL*

This is an estimate of two quite dissimilar quantities: the amount invested in materials and supplies (Acct. Nos. 151, 154 and 65 of FPC Standard Classification of Accounts), and the amount necessary to provide working capital for VPC.

Inventory of materials and supplies includes such items as fuel stocks, spare parts, maintenance materials for lines and power plants, office supplies, etc. Based on previous estimates for the end of 1970, it is estimated that the value of the inventory in future years may amount to five percent of the value of utility plant in service. This is, at best, a very approximate estimate.

Actual VPC working capital for 1970 was roughly equal to the estimate of the value of inventory. Therefore, it has been assumed that the need for inventory and working capital would together amount to ten percent of Line 1, Gross Plant in Service.

Considering the makeup of the inventory, it has been assumed that one-half of the amount for inventory or one-fourth of the combined amount for inventory and working capital would require foreign exchange.

Line 5 *RATE BASE*

This is the rate base for VPC. An estimate of the rate base is included for convenience in computing the estimated rate of return for future years. The rate of return is measured by the ratio of net operating income to the rate base. (See also Lines 24 and 25.)

Line 6 *CONSTRUCTION WORK IN PROGRESS*

This is the amount that is invested in projects that are under construction at the end of any given year. As can be seen, the amounts of money involved are quite large, and, during the early years, average almost 25 percent of the value of total plant in service. Obviously, these large amounts are properly included in determining the amount of future financing required.

For any given project, the cost of the project at a certain date will be the cumulative total of all amounts spent up to that date on the project.

Line 7 *TOTAL ASSETS*

This is the sum of Net Plant in Service, Inventory and Working Capital, and Construction Work in Progress. It is the estimated total capital invested in VPC for any given year.

Line 8 *EQUITY CAPITAL*

These are estimates of the amounts of equity capital that will have to be invested in VPC for the years indicated. Equity capital includes, of course, all forms of so-called risk capital such as capital stock, earned surplus, etc.

For the years 1972–1978, these estimates are obtained by subtracting the debt capital from the total assets. (See Line 9 for calculations of debt capital.) For the years 1979–1986, equity capital is calculated so that the previous year's equity plus current year's net income, (ten percent of current year's equity) will equal current year's equity.

Line 9 DEBT CAPITAL

These are estimates of the cumulative amounts of debt capital that will have to be invested in VPC for the years indicated. Debt capital includes all forms of borrowed capital, including both domestic and foreign capital. Since all new loans will be foreign capital, and present domestic loans are being repaid, eventually debt capital will be entirely foreign capital.

For the years 1972–1978, the estimated debt capital is the sum of the previous year's debt and new loans required less scheduled debt payments. For the years 1979–1986, debt capital is obtained by subtracting the estimated equity capital from the total assets.

Line 10 TOTAL LIABILITIES

These amounts are the sums of equity capital and debt capital and equal the Total Assets, Line 7.

Line 11 AVERAGE RATE PER KILOWATTHOUR

This average rate is calculated from the Gross Revenue required, Line 12, and the estimated kilowatthour sales.

Line 12 GROSS REVENUE

These amounts are calculated to cover the estimated expenses--operation and maintenance, depreciation, taxes excluding income tax, interest on domestic loans, interest on foreign loans, and income tax--and provide a net income equal to ten percent of the equity capital. Customer service revenue is not included since it is largely offset by expense items under present policy. If this policy should be changed, as has been suggested in Section VI so that VPC instead of the customer bears the costs of service installations, revenues would have to be increased to take this change into account.

Line 13 OPERATION AND MAINTENANCE

The amounts shown include the estimated expenses for operating and maintaining the entire system of VPC. Tables in Section VI include estimated expenses for thermal and hydro production and transmission and distribution. Estimated expenses for customer accounting and collecting, sales, administration, and general were based on the estimated expenses for these items in 1971, increased by five percent per year through 1976, then gradually reduced to a reasonable cost per kilowatthour sold.

It must be emphasized that the estimated expenses for operation and maintenance involve substantial improvements in manpower efficiency as measured by kilowatthour produced and by kilowatthour sold per employe (including all categories of employes). The achievement of these improvements will require the most careful attention of managemen.

Line 14 DEPRECIATION

These amounts are the estimated annual expense charges for depreciation. See Line 2 for full explanation.

Line 15 TAXES, EXCLUDING INCOME TAX

Based on past results and judgment, these taxes are computed at 9.65 percent of Gross Revenue, Line 12.

Line 16 INTEREST ON DOMESTIC DEBT

The amounts shown represent calculated interest to be paid on domestic debts owed at the end of 1971.

Line 17 INTEREST ON FOREIGN DEBT

These amounts represent the sum of the interest on foreign debts already incurred and the calculated interest at six percent on future project loans and bond sales. It is assumed that the new debt added each year will be spread over the year, so only a half-year's interest is included for these amounts. Repayment of project loans after a five-year grace period with a 20-year payback period was also taken into account in the interest calculations.

Line 18 TAXABLE INCOME

This is the income subject to income tax. It amounts to the Gross Revenue (Line 12) less expenses (Lines 13, 14, 15, 16 and 17).

Line 19 INCOME TAX

These amounts are computed at 28.8 percent of Taxable Income, Line 18.

Line 20 NET INCOME

These amounts represent VPC's net earnings after payment of all operating expenses and payment of interest on outstanding debt. Such amounts become a source of funds in the statement of "Cash Flow", as shown on Line 4 of Table VIII–2. As mentioned in the explanation of Line 12, Gross Revenue was calculated to produce Net Income equal to ten percent of Equity Capital (Line 8).

Line 21 DEBT-EQUITY RATIO

As mentioned previously, Debt-Equity Ratio is used as one of the measures of the credit rating of an electric utility. The ratios resulting from the proposed financing plan have, therefore, been included for the various years on Lines 22 and 23.

Line 22 DEBT-PERCENT

These amounts represent the percentage of total capitalization supplied by debt capital.

Line 23 EQUITY—PERCENT

These amounts represent the percentage of total capitalization supplied by equity capital.

Line 24 NET OPERATING INCOME

These amounts (Net Income plus interest payments charged to expense, i.e., the sum of Lines 16, 17 and 20) represent the net earnings of the company which are used to determine the overall rate of return on the rate base. (See Line 5.)

Line 25 RATE OF RETURN—PERCENT

These percentages are the ratios of Net Operating Income (Line 20) to Rate Base (Line 5). Under the proposed financing plan for Plan A, the average rate of return for the 15-year period is 8.3 percent.

It should be emphasized that the resulting rate of return is dependant on the allowable net income (calculated to be ten percent of equity capital). It is entirely possible that VPC should be permitted a higher net income and a resulting higher rate of return to cover the added costs of continuing inflation and satisfactorily finance the proposed construction program.

TABLE VIII–2

PLAN A
PROPOSED UTILITY–TYPE FINANCING
CASH FLOW AND CONVERTIBILITY REQUIREMENTS

US$ Million (VN$275/US$1)

LINE	Description	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	Source of Funds															
2	Project Financing	17.4	49.2	58.7	65.7	65.6	64.0	65.6	60.5	–	–	–	–	–	–	–
3	Previous Commitments	15.4	16.8	1.2	–	–	–	–	–	–	–	–	–	–	–	–
4	Net Income	6.4	9.1	11.7	14.8	18.3	20.5	23.5	26.1	29.0	32.3	35.9	39.8	44.3	49.2	54.7
5	Depreciation	7.9	9.9	11.8	13.5	17.1	19.8	22.6	26.2	28.3	33.2	32.8	32.4	35.6	39.3	42.8
6	GVN Stock	7.4	17.9	14.6	16.8	16.3	1.4	6.9	–	–	–	–	–	–	–	–
7	Bonds	–	–	–	–	–	–	–	–	61.4	33.8	45.9	57.2	45.0	61.5	34.6
8	Total	54.5	102.9	98.0	110.8	117.3	105.7	118.6	112.8	118.7	99.3	114.6	129.4	124.9	150.0	132.1
9	Disposition of Funds															
10	Project Construction	25.6	67.3	82.4	94.0	94.6	94.0	93.6	90.3	86.0	71.6	92.6	94.3	85.[illegible]	110.4	94.3
11	Previous Commitments	19.3	21.0	1.5	–	–	–	–	–	–	–	–	–	–	–	–
12	General Plant	1.8	3.5	3.4	3.8	3.8	3.8	3.7	3.6	3.4	2.9	3.7	3.8	3.4	4.4	3.8
13	Matrl, Supp & Wrk Cap	5.7	6.0	4.5	6.6	13.3	2.8	13.7	7.5	14.[illegible]	[illegible].0	(0.6)	9.1	10.5	10.0	8.8
14	Payment on Domestic Debt	0.1	2.4	2.7	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.9	2.9	2.9	2.9	2.9
15	Payment on Foreign Debt	2.0	2.7	3.5	3.6	2.8	2.3	4.8	8.6	12.3	14.0	16.0	19.3	22.3	22.3	22.3
16	Total	54.5	102.9	98.0	110.8	117.3	105.7	118.6	112.8	118.7	99.3	114.6	129.4	124.9	150.0	132.1
17	Foreign Exchange Convertibility Requirements															
18	Fuel	14.3	15.0	11.7	13.6	16.2	17.8	19.2	17.6							
19	O&M Excluding Fuel	1.3	1.4	1.5	1.6	1.8	2.1	2.4	2.7							
20	General Plant	0.9	1.8	1.7	1.9	1.9	1.9	1.9	1.8							
21	Matrl & Supplies	1.4	1.5	1.1	1.7	3.3	0.7	3.4	1.9							
22	Interest on Foreign Debt	2.0	4.0	7.1	10.6	14.3	18.0	21.7	25.2							
23	Payment on Foreign Debt	2.0	2.7	3.5	3.6	2.8	2.3	4.8	8.6							
24	Total	21.9	26.4	26.6	33.0	40.3	42.8	53.4	57.8							

By 1980 it is assumed that there will be free convertibility of VN$ for foreign exchange and marketability for VPC securities.

NOTES:

Line 1 *SOURCE OF FUNDS*
This table shows the estimated source of funds required for the proposed construction program.

Line 2 *PROJECT FINANCING*
These amounts represent approximately 70 percent of project costs and cover foreign debt requirements for the projects.

Line 3 *PREVIOUS COMMITMENTS*
These are the estimated expenditures of foreign funds on projects under construction for which financing had been arranged prior to the end of 1971.

Line 4 *NET INCOME*
Net earnings of VPC available for construction purposes from Line 20, Table VIII–1.

Line 5 *DEPRECIATION*
In effect, these amounts represent funds collected from customers to cover the reduction in value of plant with limited life being used to provide them service, and not expended, thus providing additional cash for new construction purposes. The amounts are obtained from Line 14, Table VIII–1.

Line 6 *GVN STOCK*
These amounts represent the added investment required from GVN to cover cash requirements not otherwise available.

Line 7 As mentioned in the text, for the purposes of this study, it is assumed that VPC would have free convertibility of internally generated funds beginning in 1980. The amounts shown represent the amount of bonds required to complete the construction program.

Line 8 TOTAL
These are the yearly totals of the source of funds.

Line 9 DISPOSITION OF FUNDS
This table shows how the funds obtained will be used.

Line 10 PROJECT CONSTRUCTION
These amounts are the estimated total project costs required each year.

Line 11 PREVIOUS COMMITMENTS
These amounts are the estimated total expenditures on projects under construction for which financing had been arranged prior to the end of 1971.

Line 12 GENERAL PLANT
These are the requirements for General Plant as described under Notes to Table VIII–1, Line 1.

Line 13 MATERIAL, SUPPLIES, AND WORKING CAPITAL
Notes to Table VIII–1, Line 4, explain how these amounts were obtained.

Line 14 PAYMENT ON DOMESTIC DEBT
These are the presently scheduled repayments of domestic obligations existing at the end of 1971.

Line 15 PAYMENT ON FOREIGN DEBT
These amounts represent the sum of scheduled repayments of foreign debts existing at the end of 1971 and repayments of project financing loans after a 5-year grace period with a 20-year payout period.

Line 16 TOTAL
These are the yearly totals of the disposition of funds.

Line 17 FOREIGN EXCHANGE CONVERTIBILITY REQUIREMENTS
This is a tabulation of the amounts of foreign exchange required in addition to the foreign exchange obtained from project financing.

Line 18 FUEL
Presently, all fuel for production plant purposes must be imported and therefore requires foreign exchange.

Line 19 OPERATION AND MAINTENANCE EXCLUDING FUEL
It is estimated that approximately 50 percent of materials and supplies consumed in operation and maintenance will require foreign exchange. Based on the break down of expenses for 1970, these amounts are estimated at 15 percent of the total operation and maintenance excluding fuel.

Line 20 GENERAL PLANT
Again, it is estimated that foreign exchange requirements will be 50 percent of the total. Hence, these amounts are one half of the totals shown on Line 12.

Line 21 MATERIAL AND SUPPLIES
As previously described, these amounts are one-fourth of the totals of Material, Supplies, and Working Capital shown on Line 13.

Line 22 INTEREST ON FOREIGN DEBT
See Notes to Table VIII–1, Line 17.

Line 23 PAYMENT ON FOREIGN DEBT
See Line 15, above.

Line 24 TOTAL
These are the yearly totals of the foreign exchange convertibility requirements.

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TABLE VIII-3

PLAN B
PROPOSED UTILITY-TYPE FINANCING
PLANT, CAPITAL, AND OPERATING STATEMENT

US$ Million (VN$275/US$1)

Line	Description	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	Gross Plant in Service	147.9	207.0	250.6	282.4	339.7	458.9	485.3	612.9	680.6	705.0	704.3	832.8	908.3	1 011.6	1 099.4
2	Depreciation Reserve	(29.4)	(37.7)	(47.9)	(59.2)	(72.2)	(88.2)	(106.6)	(127.7)	(152.2)	(178.2)	(128.9)	(154.7)	(184.4)	(216.8)	(252.8)
3	Net Plant in Service	118.5	169.3	202.7	223.2	267.5	370.7	378.7	485.2	528.4	526.8	575.4	678.1	723.9	794.8	846.6
4	Matrl, Supp & Wrk Cap	14.8	20.7	25.1	28.2	34.0	45.9	48.5	61.3	68.1	70.5	70.4	83.3	90.8	101.2	109.9
5	Rate Base	133.3	190.0	227.8	251.4	301.5	416.6	427.2	546.5	596.5	597.3	645.8	761.4	814.7	896.0	956.5
6	Const Work in Progress	15.1	27.2	52.3	98.2	130.3	87.1	126.6	59.3	58.7	103.6	117.1	82.7	116.5	111.4	116.2
7	Total Assets	148.4	217.2	280.1	349.6	431.8	503.7	553.8	605.8	655.2	700.9	762.9	844.1	931.2	1 007.4	1 072.7
8	Equity Capital	61.6	84.1	104.8	126.7	154.0	179.4	199.3	221.4	246.0	273.3	303.7	337.4	374.9	416.6	462.9
9	Debt Capital	86.8	133.1	175.3	222.9	277.8	324.3	354.5	384.4	409.2	427.6	459.2	505.7	556.3	590.8	609.8
10	Total Liabilities	148.4	217.2	280.1	349.6	431.8	503.7	553.8	605.8	655.2	700.9	762.9	844.1	931.2	1 007.4	1 072.7
11	Average Rate/kWh	3.39	3.12	2.85	2.82	2.81	2.72	2.65	2.48	2.36	2.24	2.13	2.02	2.01	2.01	1.99
12	Gross Revenue	48.00	57.39	62.14	70.66	82.20	95.02	107.75	118.22	125.48	136.59	144.60	156.43	174.40	196.19	212.51
13	Less O&M	(22.77)	(24.46)	(21.75)	(22.64)	(24.47)	(26.42)	(30.40)	(32.21)	(30.18)	(33.51)	(36.24)	(40.22)	(44.42)	(53.04)	(56.04)
14	Depreciation	(7.94)	(9.83)	(11.72)	(12.79)	(14.47)	(17.50)	(19.89)	(22.56)	(25.97)	(27.51)	(26.22)	(25.81)	(29.67)	(32.37)	(35.98)
15	Taxes, Excl Income	(4.63)	(5.54)	(6.00)	(6.82)	(7.93)	(9.17)	(10.40)	(11.41)	(12.11)	(13.18)	(13.95)	(15.09)	(16.83)	(18.93)	(20.51)
16	Interest (Domestic)	(2.08)	(2.34)	(2.26)	(2.11)	(1.96)	(1.82)	(1.67)	(1.52)	(1.37)	(1.22)	(1.08)	(0.93)	(0.78)	(0.63)	(0.51)
17	Interest (Foreign)	(1.93)	(3.41)	(5.69)	(8.51)	(11.74)	(14.91)	(17.40)	(19.43)	(21.30)	(22.78)	(24.45)	(26.99)	(30.05)	(32.71)	(34.46)
18	Taxable Income	8.65	11.81	14.72	17.79	21.63	25.20	27.99	31.09	34.55	38.39	42.66	47.39	52.65	58.51	65.01
19	Income Tax	(2.49)	(3.40)	(4.24)	(5.12)	(6.23)	(7.26)	(8.06)	(8.95)	(9.95)	(11.06)	(12.29)	(13.65)	(15.16)	(16.85)	(18.72)
20	Net Income	6.16	8.41	10.48	12.67	15.40	17.94	19.93	22.14	24.60	27.33	30.37	33.74	37.49	41.66	46.29
21	Debt-Equity Ratio															
22	Debt-Percent	58.5	61.3	62.6	63.8	64.3	64.4	64.0	63.5	62.5	61.0	60.2	60.0	59.7	58.6	56.8
23	Equity-Percent	41.5	38.7	37.4	36.2	35.7	35.6	36.0	36.5	37.5	39.0	39.8	40.0	40.3	41.4	43.2
24	Net Operating Income	10.17	14.16	18.43	23.29	29.10	34.67	39.00	43.09	47.27	51.33	55.90	61.66	68.32	75.00	81.26
25	Rate of Return - Percent	7.63	7.45	8.09	9.26	9.65	8.32	9.13	7.88	7.92	8.59	8.66	8.10	8.39	8.37	8.50

TABLE VIII-4

PLAN B
PROPOSED UTILITY-TYPE FINANCING
CASH FLOW AND CONVERTIBILITY REQUIREMENTS

US$ Million (VN$275/US$1)

Line	Description	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	Source of Funds															
2	Project Financing	14.6	34.6	47.2	54.0	60.5	51.5	36.9	39.9	–	–	–	–	–	–	–
3	Previous Commitments	15.4	16.8	1.2	–	–	–	–	–	–	–	–	–	–	–	–
4	Net Income	6.2	8.4	10.5	12.7	15.4	17.9	19.9	22.1	24.6	27.3	30.4	33.7	37.5	41.7	46.3
5	Depreciation	7.9	9.8	11.7	12.8	14.5	17.5	19.9	22.6	26.0	27.5	26.2	25.8	29.7	32.4	36.0
6	GVN Stock	5.7	14.1	10.2	9.2	11.9	7.5	–	–	–	–	–	–	–	–	–
7	Bonds	–	–	–	–	–	–	–	–	37.9	33.0	47.6	65.4	69.5	54.4	38.9
8	Total	49.8	83.7	80.8	88.7	102.3	94.4	76.7	84.6	88.5	87.8	104.2	124.9	136.7	128.5	121.2
9	Disposition of Funds															
10	Project Construction	21.1	48.9	66.0	76.2	87.4	74.5	64.8	59.4	66.0	68.1	84.9	90.5	105.1	94.4	89.0
11	Previous Commitments	19.3	21.0	1.5	–	–	–	–	–	–	–	–	–	–	–	–
12	General Plant	1.6	2.8	2.7	3.0	3.5	3.0	2.6	2.4	2.6	2.7	3.4	3.6	4.2	3.8	3.6
13	Matrl,Supp & Wrk Cap	5.7	5.9	4.4	3.1	5.8	11.9	2.6	12.8	6.8	2.4	(0.1)	12.9	7.5	10.4	8.7
14	Payment on Domestic Debt	0.1	2.4	2.7	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.9	2.9	2.9	2.9	2.9
15	Payment on Foreign Debt	2.0	2.7	3.5	3.6	2.8	2.2	3.9	7.2	10.3	11.8	13.1	15.0	17.0	17.0	17.0
16	Total	49.8	83.7	80.8	88.7	102.3	94.4	76.7	84.6	88.5	87.8	104.2	124.9	136.7	128.5	121.2
17	Foreign Exchange Convertibility Requirements															
18	Fuel	14.3	15.0	11.7	12.1	13.0	13.8	16.5	17.1							
19	O&M Excluding Fuel	1.2	1.4	1.5	1.6	1.7	2.0	2.2	2.5							
20	General Plant	0.8	1.4	1.4	1.5	1.8	1.5	1.3	1.2							
21	Matrl & Supplies	1.4	1.5	1.1	0.8	1.5	3.0	0.7	3.2							
22	Interest on Foreign Debt	1.9	3.4	5.7	8.5	11.7	14.9	17.4	19.4							
23	Payment on Foreign Debt	2.0	2.7	3.5	3.6	2.8	2.2	3.9	7.2							
24	Total	21.6	25.4	24.9	28.1	32.5	37.4	42.0	50.6							

By 1980 it is assumed that there will be free convertibility of VN$ for foreign exchange and marketability for VPC securities.

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TABLE VIII-5

PLAN C
PROPOSED UTILITY-TYPE FINANCING
PLANT, CAPITAL, AND OPERATING STATEMENT

US$ Million (VN$275/US$1)

Line	Description	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	Gross Plant in Service	90.5	148.1	208.9	254.4	320.3	454.0	585.0	662.1	691.4	834.1	914.6	909.1	1 000.0	1 105.8	1 255.7	1 345.3
2	Depreciation Reserve	(23.0)	(29.4)	(37.9)	(48.2)	(60.2)	(75.8)	(96.0)	(119.3)	(144.8)	(172.4)	(204.1)	(161.4)	(193.8)	(229.4)	(268.8)	(313.5)
3	Net Plant in Service	67.5	118.7	171.0	206.2	260.1	378.2	489.0	542.8	546.6	661.7	710.5	747.7	806.2	876.4	986.9	1 031.8
4	Matrl, Supp & Wrk Cap	9.1	14.6	20.9	25.4	32.0	45.4	58.5	66.2	69.1	83.4	91.5	90.9	100.0	110.6	125.6	134.5
5	Rate Base	76.6	133.5	191.9	231.6	292.1	423.6	547.5	609.0	615.7	745.1	802.0	838.6	906.2	987.0	1 112.5	1 166.3
6	Const Work in Progress	32.0	19.6	62.8	121.0	157.0	124.9	77.8	78.6	126.7	69.0	73.4	113.1	125.7	145.5	113.8	170.3
7	Total Assets	108.6	153.1	254.7	352.6	449.1	548.5	625.3	687.6	742.4	814.1	875.4	951.7	1 031.9	1 132.5	1 226.3	1 336.6
8	Equity Capital	49.7	63.5	95.1	127.8	161.4	197.5	223.0	247.8	275.3	305.9	339.9	377.7	419.7	466.3	518.1	575.7
9	Debt Capital	58.9	89.6	159.6	224.8	287.7	351.0	402.3	439.8	467.1	508.2	535.5	574.0	612.2	666.2	708.2	760.9
10	Total Liabilities	108.6	153.1	254.7	352.6	449.1	548.5	625.3	687.6	742.4	814.1	875.4	951.7	1 031.9	1 132.5	1 226.3	1 336.6
11	Average Rate/kWh		3.42	3.23	2.87	2.81	2.64	2.52	2.41	2.28	2.24	2.14	2.12	2.06	2.06	2.03	2.02
12	Gross Revenue		48.49	60.23	68.44	82.65	100.87	114.72	127.39	138.07	149.83	163.37	177.68	193.04	213.13	233.44	255.49
13	Less O&M		(22.86)	(24.55)	(21.84)	(24.43)	(28.43)	(29.37)	(31.59)	(33.08)	(35.20)	(36.44)	(42.46)	(48.52)	(54.18)	(58.61)	(62.32)
14	Depreciation		(7.94)	(9.87)	(11.82)	(13.52)	(17.13)	(21.70)	(24.81)	(27.02)	(29.10)	(33.23)	(32.84)	(32.44)	(35.62)	(39.39)	(44.65)
15	Taxes, Excl Income		(4.68)	(5.81)	(6.60)	(7.98)	(9.73)	(11.07)	(12.29)	(13.32)	(14.46)	(15.76)	(17.15)	(18.63)	(20.57)	(22.53)	(24.65)
16	Interest (Domestic)		(2.08)	(2.34)	(2.26)	(2.11)	(1.96)	(1.82)	(1.67)	(1.52)	(1.37)	(1.22)	(1.08)	(0.93)	(0.78)	(0.63)	(0.51)
17	Interest (Foreign)		(2.01)	(4.30)	(7.97)	(11.95)	(15.88)	(19.44)	(22.29)	(24.46)	(26.74)	(28.98)	(31.11)	(33.57)	(36.49)	(39.52)	(42.50)
18	Taxable Income		8.92	13.36	17.95	22.66	27.74	31.32	34.81	38.67	42.96	47.74	53.04	58.95	65.49	72.76	80.86
19	Income Tax		(2.57)	(3.85)	(5.17)	(6.52)	(7.99)	(9.02)	(10.03)	(11.14)	(12.37)	(13.75)	(15.27)	(16.98)	(18.86)	(20.95)	(23.29)
20	Net Income		6.35	9.51	12.78	16.14	19.75	22.30	24.78	27.53	30.59	33.99	37.77	41.97	46.63	51.81	57.57
21	Debt-Equity Ratio																
22	Debt-Percent		58.5	62.7	63.8	64.1	64.0	64.3	64.0	62.9	62.4	61.2	60.3	59.3	58.8	57.8	56.9
23	Equity-Percent		41.5	37.3	36.2	35.9	36.0	35.7	36.0	37.1	37.6	38.8	39.7	40.7	41.2	42.2	43.1
24	Net Operating Income		10.44	16.15	23.01	30.20	37.59	43.56	48.74	53.51	58.70	64.19	69.96	76.47	83.90	91.96	100.58
25	Rate of Return — Percent		7.82	8.42	9.94	10.34	8.87	7.96	8.00	8.69	7.88	8.00	8.34	8.44	8.50	8.27	8.62

TABLE VIII-6

PLAN C
PROPOSED UTILITY-TYPE FINANCING
CASH FLOW AND CONVERTIBILITY REQUIREMENTS

US$ Million (VN$275/US$1)

Line	Description	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	Source of Funds															
2	Project Financing	17.4	58.3	70.2	69.3	68.9	56.4	45.6	39.7	–	–	–	–	–	–	–
3	Previous Commitments	15.4	16.8	1.2	–	–	–	–	–	–	–	–	–	–	–	–
4	Net Income	6.4	9.5	12.8	16.1	19.8	22.3	24.8	27.5	30.6	34.0	37.8	42.0	46.6	51.8	57.6
5	Depreciation	7.9	10.0	11.8	13.5	17.1	21.7	24.8	27.0	29.1	33.2	32.8	32.4	35.6	39.4	44.7
6	GVN Stock	7.4	22.1	19.9	17.5	16.3	3.2	–	–	–	–	–	–	–	–	–
7	Bonds	–	–	–	–	–	–	–	–	57.4	45.5	58.4	60.4	78.2	66.2	76.9
8	Total	54.5	116.7	115.9	116.4	122.1	103.6	95.2	94.2	117.1	112.7	129.0	134.8	160.4	157.4	179.2
9	Disposition of Funds															
10	Project Construction	25.6	80.4	99.7	99.4	99.1	82.1	76.3	75.9	83.2	83.1	105.5	99.5	120.8	113.7	140.5
11	Previous Commitments	19.3	21.0	1.5	–	–	–	–	–	–	–	–	–	–	–	–
12	General Plant	1.8	4.1	4.0	4.0	4.0	3.3	3.1	3.0	3.3	3.3	4.2	4.0	4.8	4.5	5.6
13	Matrl, Supp & Wrk Cap	5.7	6.1	4.5	6.6	13.4	13.1	7.7	2.9	14.3	8.1	(0.6)	9.1	10.6	15.0	8.9
14	Payment on Domestic Debt	0.1	2.4	2.7	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.9	2.9	2.9	2.9	2.9
15	Payment on Foreign Debt	2.0	2.7	3.5	3.6	2.8	2.3	5.3	9.6	13.5	15.4	17.0	19.3	21.3	21.3	21.3
16	Total	54.5	116.7	115.9	116.4	122.1	103.6	95.2	94.2	117.1	112.7	129.0	134.8	160.4	157.4	179.2
17	Foreign Exchange Convertibility Requirements															
18	Fuel	14.3	15.0	11.7	13.6	16.2	15.0	15.1	15.1							
19	O&M Excluding Fuel	1.3	1.4	1.5	1.6	1.8	2.2	2.5	2.7							
20	General Plant	0.9	2.1	2.0	2.0	2.0	1.7	1.6	1.5							
21	Matrl & Supplies	1.4	1.5	1.1	1.7	3.4	3.3	1.9	0.7							
22	Interest on Foreign Debt	2.0	4.3	8.0	12.0	15.9	19.4	22.3	24.5							
23	Payment on Foreign Debt	2.0	2.7	3.5	3.6	2.8	2.3	5.3	9.6							
24	Total	21.9	27.0	27.8	34.5	42.1	43.9	48.7	54.1							

By 1980 it is assumed that there will be free convertibility of VN$ for foreign exchange and marketability for VPC securities.

TABLE VIII-7

PLAN A
FINANCING WITH COMMERCIAL LOANS INSTEAD OF SECURITIES
PLANT, CAPITAL, AND OPERATING STATEMENT

US$ Million (VN$275/US$1)

Line	Description	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	Gross Plant in Service	148.1	208.3	253.2	318.9	452.4	479.9	617.2	691.5	834.3	914.4	908.4	999.1	1 103.5	1 203.8	1 391.6
2	Depreciation Reserve	(29.4)	(37.8)	(48.1)	(60.1)	(75.7)	(94.0)	(115.1)	(139.8)	(166.6)	(198.3)	(155.6)	(188.0)	(223.6)	(262.9)	(305.7)
3	Net Plant in Service	118.7	170.5	205.1	258.8	376.7	385.9	502.1	551.7	667.7	716.1	752.8	811.1	879.9	940.0	985.9
4	Matrl, Supp & Wrk Cap	14.8	20.8	25.3	31.9	45.2	48.0	61.7	69.2	83.4	91.4	90.8	99.9	110.4	120.4	129.2
5	Rate Base	133.5	191.3	230.4	290.7	421.9	433.9	563.8	620.9	751.1	807.5	843.6	911.0	990.3	1 061.3	1 115.1
6	Const Work in Progress	19.6	49.7	90.6	121.2	84.6	153.4	111.9	130.0	75.1	68.0	94.8	102.2	87.0	101.5	111.8
7	Total Assets	153.1	241.0	321.0	411.9	506.5	587.3	675.7	750.9	826.2	875.5	938.4	1 013.2	1 077.3	1 162.8	1 226.9
8	Equity Capital	55.2	61.3	68.1	75.7	84.1	93.4	103.8	115.3	128.1	142.3	158.1	175.7	195.2	216.9	241.0
9	Debt Capital	97.9	179.7	252.9	336.2	422.4	493.9	571.9	635.6	698.1	733.2	780.3	837.5	882.1	945.9	985.9
10	Total Liabilities	153.1	241.0	321.0	411.9	506.5	587.3	675.7	750.9	826.2	875.5	938.4	1 013.2	1 077.3	1 162.8	1 226.9
11	Average Rate/kWh	3.39	3.13	2.76	2.72	2.58	2.52	2.46	2.37	2.32	2.19	2.13	2.05	2.03	1.97	1.93
12	Gross Revenue	48.03	58.39	65.90	79.89	98.56	114.73	129.67	143.08	155.00	166.90	178.40	191.86	209.46	227.11	243.95
13	Less O & M	(22.86)	(24.55)	(21.84)	(24.43)	(28.43)	(31.92)	(34.94)	(35.38)	(36.77)	(36.58)	(42.54)	(48.66)	(54.27)	(58.75)	(62.59)
14	Depreciation	(7.94)	(9.86)	(11.79)	(13.48)	(17.08)	(19.84)	(22.57)	(26.24)	(28.29)	(33.23)	(32.83)	(32.42)	(35.57)	(39.31)	(42.80)
15	Taxes, Excl Income	(4.63)	(5.63)	(6.36)	(7.71)	(9.51)	(11.07)	(12.53)	(13.81)	(14.96)	(16.11)	(17.22)	(18.51)	(20.21)	(21.92)	(23.54)
16	Interest (Domestic)	(2.83)	(5.72)	(9.27)	(13.04)	(17.40)	(20.76)	(23.54)	(26.21)	(28.56)	(29.98)	(30.01)	(31.13)	(33.00)	(34.99)	(36.92)
17	Interest (Foreign)	(2.01)	(4.02)	(7.08)	(10.60)	(14.33)	(18.02)	(21.71)	(25.25)	(28.43)	(31.02)	(33.60)	(36.46)	(38.99)	(41.68)	(44.25)
18	Taxable Income	7.76	8.61	9.56	10.62	11.81	13.12	14.58	16.19	17.99	19.98	22.20	24.68	27.42	30.46	33.85
19	Income Tax	(2.24)	(2.48)	(2.75)	(3.06)	(3.40)	(3.78)	(4.20)	(4.66)	(5.18)	(5.75)	(6.39)	(7.11)	(7.90)	(8.77)	(9.75)
20	Net Income	5.52	6.13	6.81	7.57	8.41	9.34	10.38	11.53	12.81	14.23	15.81	17.57	19.52	21.69	24.10
21	Debt–Equity Ratio															
22	Debt – Percent	63.9	74.6	78.8	81.6	83.4	84.1	84.6	84.6	84.5	83.7	83.2	82.7	81.9	81.3	80.4
23	Equity – Percent	36.1	25.4	21.2	18.4	16.6	15.9	15.4	15.4	15.5	16.3	16.8	17.3	18.1	18.7	19.6
24	Net Operating Income	10.36	15.87	23.16	31.21	40.14	43.12	55.63	62.99	69.90	75.23	79.42	85.16	91.51	98.36	105.27
25	Rate of Return – Percent	7.76	8.30	10.05	10.74	9.51	11.09	9.87	10.14	9.29	9.32	9.41	9.35	9.24	9.27	9.44

NOTES:

Lines 1 to 7 INCLUSIVE
See Notes to Table VIII–1.

Line 8 EQUITY CAPITAL
These amounts are calculated so that the previous year's equity plus current year's net income (ten percent of current year's equity) will equal current year's equity.

Line 9 DEBT CAPITAL
These amounts represent total debt required, i.e., total assets less equity capital. Added debt requirements not covered by project financing are assumed to be obtained from domestic sources at 18 percent interest. (See also Notes to Table VIII–8.)

Lines 10 to 25 INCLUSIVE
See Notes to Table VIII–1.
Note that Line 16 also includes interest on added domestic borrowings at 18 percent interest. Also see text for comparisons of Debt-Equity Ratio and Rate of Return.

TABLE VIII–8

PLAN A
FINANCING WITH COMMERCIAL LOANS INSTEAD OF SECURITIES
CASH FLOW AND CONVERTIBILITY REQUIREMENTS

US$ Million (VN$275/US$1)

Line	Description	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	Source of Funds															
2	Project Financing	17.4	49.2	58.7	65.7	65.6	64.0	65.6	63.8	61.1	50.9	65.2	66.1	60.8	77.7	62.9
3	Previous Commitments	15.4	16.8	1.2	–	–	–	–	–	–	–	–	–	–	–	–
4	Net Income	5.5	6.1	6.8	7.6	8.4	9.3	10.4	11.5	12.8	14.2	15.8	17.6	19.5	21.7	24.1
5	Depreciation	7.9	9.9	11.8	13.5	17.1	19.8	22.6	26.2	28.3	33.2	32.8	32.4	35.6	39.3	42.8
6	18 Percent Debt	8.3	21.3	21.0	26.5	30.1	18.0	26.3	18.9	25.0	10.8	11.1	24.2	21.3	27.7	22.6
7	Total	54.5	103.3	99.5	113.3	121.2	111.1	124.9	120.4	127.2	109.1	124.9	140.3	137.2	166.4	152.4
8	Disposition of Funds															
9	Project Construction	25.6	67.3	82.4	94.0	94.6	94.0	93.6	90.3	86.0	71.6	92.6	94.3	85.8	110.4	94.3
10	Previous Commitments	19.3	21.0	1.5	–	–	–	–	–	–	–	–	–	–	–	–
11	General Plant	1.8	3.5	3.4	3.8	3.8	3.8	3.7	3.6	3.4	2.9	3.7	3.8	3.4	4.4	3.8
12	Matrl,Supp & Wrk Cap	5.7	6.0	4.5	6.6	13.3	2.8	13.7	7.5	14.2	8.0	(0.6)	9.1	10.5	10.0	8.8
13	Payment on Domestic Debt	0.1	2.8	4.2	5.3	6.7	8.2	9.1	10.4	11.3	12.6	13.2	13.8	15.0	16.0	17.4
14	Payment on Foreign Debt	2.0	2.7	3.5	3.6	2.8	2.3	4.8	8.6	12.3	14.0	16.0	19.3	22.5	25.6	28.1
15	Total	54.5	103.3	99.5	113.3	121.2	111.1	124.9	120.4	127.2	109.1	124.9	140.3	137.2	166.4	152.4
16	Foreign Exchange Convertibility Requirements															
17	Fuel	14.3	15.0	11.7	13.6	16.2	17.8	19.2	17.6	17.4	14.7	18.5	22.2	25.4	27.2	28.3
18	O&M Excluding Fuel	1.3	1.4	1.5	1.6	1.8	2.1	2.4	2.7	2.9	3.3	3.6	4.0	4.3	4.7	5.1
19	General Plant	0.9	1.8	1.7	1.9	1.9	1.9	1.9	1.8	1.7	1.5	1.9	1.9	1.7	2.2	1.9
20	Matrl & Supplies	1.4	1.5	1.1	1.7	3.3	0.7	3.4	1.9	3.6	2.0	(0.2)	2.3	2.6	2.5	2.2
21	Interest on Foreign Debt	2.0	4.0	7.1	10.6	14.3	18.0	21.7	25.2	28.4	31.0	33.6	36.5	39.0	41.7	44.3
22	Payment on Foreign Debt	2.0	2.7	3.5	3.6	2.8	2.3	4.8	8.6	12.3	14.0	16.0	19.3	22.5	25.6	28.1
23	Total	21.9	26.4	26.6	33.0	40.3	42.8	53.4	57.8	66.3	66.5	73.4	86.2	95.5	103.9	109.9

NOTES:

Lines 1 to 5 INCLUSIVE
See Notes to Table VIII–2.

Line 6 18 PERCENT DEBT
The amounts shown represent the additional debt financing required after project financing which is assumed to be domestic borrowings at 18 percent interest.

Lines 7 to 12 INCLUSIVE
See Notes to Table VIII–2, Lines 8 to 13 inclusive.

Line 13 PAYMENT ON DOMESTIC DEBT
These are the sums of the presently scheduled repayments of domestic obligations existing at the end of 1971 and repayments of the new domestic obligations. It is assumed that repayments of the new loans would be based on a 20-year term with no grace period.

Line 14 PAYMENT ON FOREIGN DEBT
These amounts are the same as shown on Line 15, Table VIII–2, except that repayment of project financing loans continues for the full period rather than using permanent financing with bonds beginning in 1980.

Lines 15 to 23 INCLUSIVE
See Notes to Table VIII–2, Lines 16 to 24 inclusive.

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COMPUTER EQUIPMENT

MST devoted a great deal of attention to the development of a useful computer department in VPC. The discussions, conclusions, and recommendations in their report form a basis for recommendations made in this report concerning the development of a computer department in VPC.

Existing Situation

Equipment

As of October, 1971 VPC's DPC included one IBM 360/20 computer with two disk drives, several sorting machines, and card punchers. The computer was installed in March, 1969 by SPC before the merger with EOV. At that time, SPC had 120 000 customers and 1578 employes, including 27 in DPC. By September, 1971 VPC had 221 000 customers and 4336 employes, including 88 in DPC. The equipment is operated on a two-shift basis. The equipment is inadequate in capacity. It is using the RPG programming language because it cannot accept any of the modern, versatile, and efficient languages such as COBOL and FORTRAN.

The space now being used is much too small, and VPC plans to make available necessary space for the future needs of DPC.

Organization

DPC is organized into two divisions: Operations which includes processing, programming, control, and analysis; and Data Preparation which includes sorting and punching. Staff and technical personnel include a manager, assistant manager, and one full-time and one part-time computer system analyst. Both computer system analysts have had university training.

Operations

The four major types of jobs being run in DPC are billing, cash receipts, inventory, and finance and accounting.

The present billing procedure consists of punching, sorting, and printing invoices and the processor is used mainly as a high-speed typewriter. Assuming a 20 percent growth rate per year, the number of customers will double in five years. The present system of invoicing and recording cash collections must be revised because the equipment will not be able to handle the load.

A recent improvement in the cash collection procedure is the use of an IBM billing card. The collector, at the end of the day, has two batches of cards -- paid and uncollectible. DPC prints out a list by customer account of the uncollectibles and runs the paid cards through the machine accumulating totals. Using the simple formula of amount billed equals paid plus uncollectibles, totals are checked and compared with bank receipts. Paid cards are filed for possible reference by an auditor and can be printed by customer account, if required.

DPC prints a month-end inventory list which, however, is several months late due to late inputs. A daily transactions list is also printed. A detailed flow chart and a plan are needed.

In matters involving finance and accounting, DPC makes specialized runs on an irregular basis. There are no records, flow charts, or scheduling of these runs. The need exists to analyze these and establish regular monthly schedules to include preparation of financial statements on an up-to-date basis.

Jobs are not scheduled on a monthly basis. A monthly schedule should be prepared showing jobs allocated to machines in order to better plan the processing of new jobs. This can be accomplished by the development and implementation of a Gantt chart.

The computer is now being used as follows: 49 percent for billing; 32 percent for accounting; 11 percent for inventory; 6 percent for payroll; and 2 percent for other work which includes work for other departments of government. Its utilization factor (machine time/actual shift time) is 60 percent.

DPC is now operating under the handicaps of insufficient floor space, inadequate equipment, and lack of trained personnel. Each of these problem areas is mutually dependent on the others. They all must be solved concurrently.

The space problem is most critical. Cards and forms are ordered in large quantities to reduce costs. They are stored along the walls and on the tops of cabinets and create a fire and a safety hazard and reduce the efficiency of the air conditioning system which, in turn, affects the operation of the central processing unit. In addition, the amount of office space is most inadequate. Any increase in personnel can barely be accommodated because there is little available space for desks.

The present IBM 360/20 system is inadequate because the programming language is not business oriented; the speed of the printer is too slow; and there are no tape drives. The RPG language generates report formats only and is cumbersome

to use. The generally accepted language for business is COBOL and for engineering is FORTRAN. The 360/20 does not accept these languages. The rated speed of the printer is 1100 lines/minute but because it is used with the 360/20, it can only be used at 600–700 lines per minute. This is not fast enough when future demands are taken in consideration. DPC depends heavily on cards because it does not have tape drives or a sufficient number of disks to store customer data, payroll, inventory, and personnel information. The printer and central processing unit are almost fully machine loaded now. The monthly meter time for these units is 267 hours. Assuming an additional 213 hours per month for setup time and maintenance, 480 hours per month are required. This is equivalent to a 16-hour day. This full two-shift utilization barely allows for new jobs and machine breakdowns.

The present organization is seriously lacking in well-trained, academically qualified and experienced personnel. About six months ago, the first college-trained computer systems specialist was hired. There is a need for at least five more. Starting salaries are very low. There is no on-going training program.

It is estimated that VPC power generation will grow approximately 20 percent per year for the next five years. The impact of this growth on DPC operations will be catastrophic unless new equipment is procured.

It is estimated that the number of customers will nearly double in the next five years. Billing presently utilizes 130 hours per month of processing time. This will increase to about 250 hours per month by 1976.

Payroll presently utilizes 16 hours per month of processing time. This will increase to about 20 hours per month by 1976.

The number of inventory transactions will increase about 200 percent in the next five years. Inventory reports presently utilize 28 hours per month of processing time. This will increase to about 84 hours per month by 1976.

The machine time consumed for the accounting reports and statements will increase by an estimated 20 percent because of the increase in number of province offices from 38 to 44 and the installation of a cost control system. Accounting presently uses 87 hours per month of processing time. This will increase to about 100 hours per month by 1976.

The machine time consumed for other reports presently amounts to six hours per month of processing time. It is estimated that this will increase to ten hours per month in 1976. It is assumed that ten hours per month will be required in 1976 for engineering.

The following table summarizes the present use of the equipment and the expected use by 1976.

Function	1971 Hours per month	1976 Hours per month
Billing	130	250
Payroll	16	20
Inventory	28	84
Accounting	87	100
Other	6	10
Engineering	0	10
Total	267	474

Present processing meter time is 267 hours per month for two shifts or 480 actual hours per month. This means a utilization factor of 60 percent which is quite good considering that the Taiwan Power Company has a factor of 74 percent, and the average usually attained in the US is 70 percent. The difference between clock and actual hours is caused by setups, adjustments, and maintenance. Based on the above data, there will be an increase of 40 clock hours per month per year due to growth. This means that three-shift saturation will occur in approximately three years.

MST requested two sources, IBM World Trade Corporation, Saigon; and the Deputy Director, Data Processing Center, Taiwan Power Company, to review VPC requirements for the next five years.

Both sources admit that the present equipment will be inadequate in a year to a year and a half and that procurement of new equipment should be initiated now because of the eighteen–month to two–year procurement lead time.

IBM recommends the 360/40, three disk drives, two tape drives, and one printer. Taiwan Power recommends the 370/135, three disk drives, two tape drives, and one printer.

IBM announced the 370/135 system in the US in July, 1970 and in Taiwan in January, 1971. However, for some reason, probably area preference, IBM has not announced its availability in Vietnam.

MST recommends procurement of the 370/135 system because:

1. It is over twice as fast as the 360/40,

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thereby permitting faster printing of bills and reports.

2. Core memory is 50 percent more than the 360/40 allowing greater computational versatility.

3. Reliability and serviceability are better.

4. Monthly rental charge for both systems is approximately the same.

It would be unwise to procure the slower 360/40 system and possibly have an inadequate system in four or five years.

Additional peripheral equipment should include three disk drives, two tape drives, and one high-speed printer. Although two printers will not be needed in two years, consideration should be given to the purchase of an additional printer in about three years for the versatility of printing several programs concurrently.

The estimated monthly charge for the above 370/135 system (one printer) is about US$14 000.

Additional new air-conditioned space of about 12 000 square feet should be provided in the new building now under construction.

A training program should be initiated in early 1972 and additional computer system analysts having degrees should be hired as soon as possible.

One part of the training program should consist of sending DPC personnel to data processing departments at electric utilities outside Vietnam. The training would include actual work in the department of interest with counterparts.

The first part of a training program should include familiarization with accounting procedures. There is a strong interface between DPC operations and finance and accounting procedures. DPC flow charts must be developed and analyzed concurrently with the analysis of accounting procedures. A change in card layout or output reports must be studied in relationship to the associated function in accounting, i.e., generation of source data and the use of the output reports. This means that computer system analysts must be knowledgeable in accounting procedures.

A second part of the training program should provide for on-going programs. This training should be classroom oriented and held during working hours. The courses should increase the knowledge of personnel not only in their working area but also in related areas. The courses for DPC personnel should include instruction on accounting, logistics, and personnel procedures. The courses for non-DPC personnel should include instruction in computer fundamentals and data preparation.

SECTION IX
RATES

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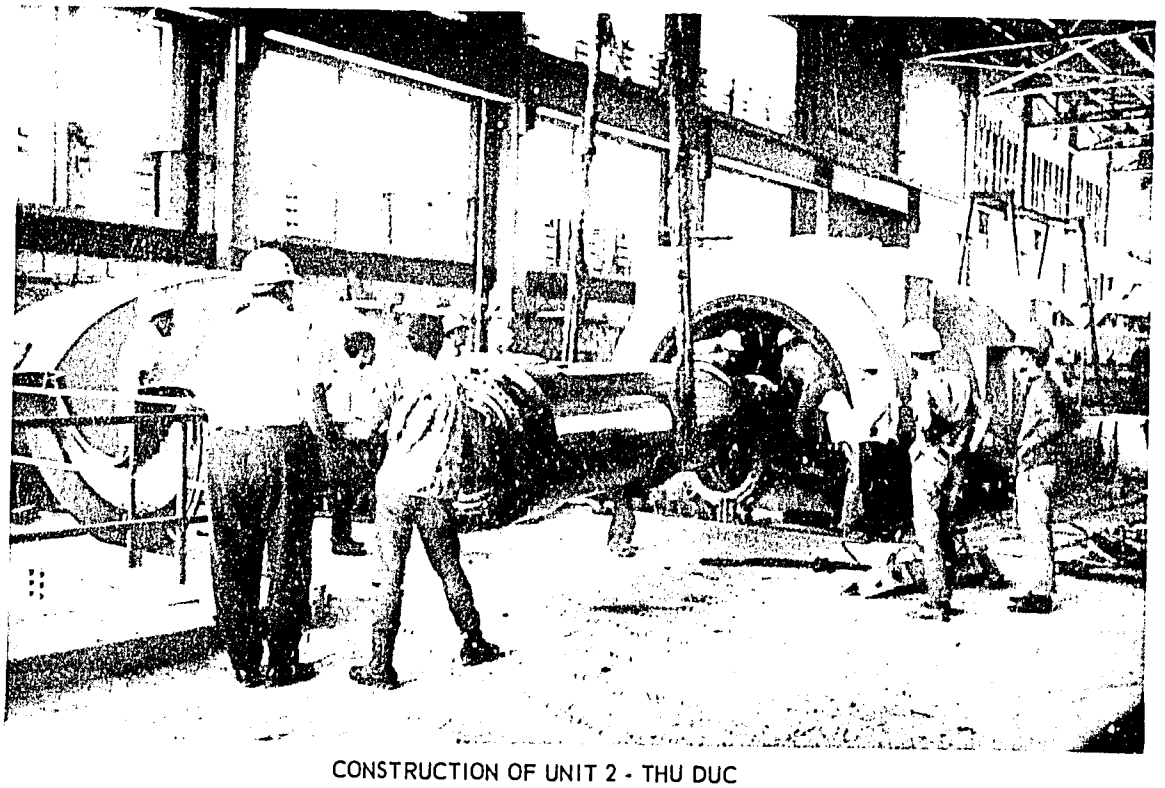
General 2

TABLES IX–

1 – Electric Rate Applicable from April 1, 1971 for Saigon and Surrounding Areas 3
2 – Provincial Electricity Rate per Kilowatthour for Each Class of Supply 4



CONSTRUCTION OF UNIT 2 - THU DUC

SECTION IX

RATES

There are three general rate levels: lighting, low-voltage power, and medium-voltage power with another rate level for street lighting in Saigon.

Rates charged customers by VPC are on a flat-rate basis plus, in most cases, additional charges for taxes and assessments.

Additional charges for taxes and assessments include:

1. Registration fee of 2.88 percent of basic rate per kilowatthour.
2. War damage "plant renewal" fund; a flat rate of VN$0.200 per kilowatthour for lighting and VN$0.050 per kilowatthour for low-voltage power.
3. City tax of VN$0.110 per kilowatthour applicable to lighting in Saigon and varying amounts in two provincial centers.
4. Production tax of 7.2 percent which is applied to the sum of the base rate and other applicable taxes and assessments.

The various rates made effective April 1, 1971 and the various applications of taxes and assessments are shown on Table IX–1 for metropolitan Saigon and on Table IX–2 for provincial centers.

As shown on Table IX–1, the three general rate levels are the same for the various groups of customers:

1. General Public
2. Administration
3. French Consulate
4. US Offices and Installations

The application of the taxes and assessments varies with the different groups. For example, the registration fee of 2.88 percent is only applied to sales to the general public; the city tax of VN$0.110 for lighting service is applied to the other three groups but not to administration sales; and the 7.2 percent production tax is included on sales to the general public, administration, and French consulate, but not to sales to US offices and installations.

The same differences between the general public and administration exist in the provinces as shown on Table IX–2.

Table IX–1 shows that total charges to customers in Saigon and vicinity based on kilowatthour sales, vary from VN$6.578 to VN$9.434 per kilowatthour (from US$0.0239 to US$0.0343 at a conversion rate of VN$275/US$1.)

Similarly, Table IX–2 shows total charges based on kilowatthour sales in most of the provinces varying from VN$12.86 to VN$17.83 per kilowatthour (US$0.0468 to US$0.0648). The exceptionally low rates in Dalat are a carryover from the days when Dalat was served with "low cost" hydro power.

In addition to the above charge based on metered kilowatthour sales, customers are billed a monthly meter rental charge. With the exception of customers receiving lighting service and air-conditioning service through two meters (as explained more fully later) in which case the customer is billed the rental for only the larger of the two meters, all customers are billed this meter rental charge. These charges vary from VN$10 to VN$35 for various sizes of single-phase meters and VN$45 to VN$210 for three-phase meters. An additional charge of VN$700 is made for high-voltage delivery.

General public customers are also billed a "stamp" tax of 0.0024 percent of the total charges based on kilowatthours and applicable taxes plus meter rental charges. This tax is collected when bills are paid in cash. However, it is not applicable if bills are paid by check.

Prior to May 1, 1969, rates were changed from month to month based on a complicated formula designed in 1956 for CEE. Effective May 1, 1969, with some minor changes, the rates in Saigon were increased VN$2 per kilowatthour, the theory being that SPC would receive one piastre of the increase, with the other piastre retained in an "equalization" fund until required to produce a reasonable return, and thus eliminate the monthly rate changes. Also, rates in the provinces – served by EOV – were increased, including an equalization fund allocation of VN$1.76 per kilowatthour.

This across-the-board increase of VN$2 per kilowatthour naturally produced a much higher increase to the lower industrial rates as compared to the lighting rate.

In the rate change made effective April 1, 1971,

rate levels based on a slight modification of the old French formula were re-established and the equalization fund allocation was reduced to VN$0.39 per kilowatthour both in Saigon and the provinces.

Under this modified formula, the medium-voltage power rate is 0.8 times the average lighting rate, and the low-voltage power rate is 0.9 times the average lighting rate. In Saigon, the average lighting rate is broken down into two rates, general public lighting and street lighting, so that the street light rate is 0.8 times the general public lighting rate. In the provinces, the street lighting rate is the same as the medium-voltage power rate.

MST has made a very thorough study of VPC's rates and has recommended an ultimate tariff limiting all metered service to three basic rates:

1. Monophase lighting and power (block-type rate).
2. Triphase lighting and power (block-type rate).
3. Medium-voltage power (block type with demand).

The minimums of such rates should be designed to cover meter rental costs and separate charges, therefore, eliminated. Street lighting should be served from distribution lines rather than separately metered circuits and billed on flat rates

TABLE IX-1

Electric Rate Applicable from April 1, 1971
For Saigon and Surrounding Areas

(Reference: Decree No. 400-CC/Electric Utility Commission and No. 460-CC/Electric Utility Commission dated April 10, 1971, Ministry of Public Works)

	VN$						
Type of Electricity Supplied	Basic Rate Per kWh	Registration Fee 2.88%	Plant Renewal Fund	City Tax	Total	Prod Tax 7.2%	Total Per kWh
General Public							
Lighting and domestic use							
Saigon-Cholon	8.252	0.238	0.200	0.110	8.800	0.634	9.434
Gia Dinh-Bien Hoa	8.252	0.238	0.200	–	8.690	0.626	9.316
Low-voltage power	7.401	0.213	0.050	–	7.664	0.552	8.216
Medium-voltage power	6.578	0.189	–	–	6.767	0.487	7.254
Administration							
Lighting and domestic use	8.252	–	0.200	–	8.452	0.609	9.061
Street lighting	6.601	–	0.200	–	6.801	0.490	7.291
Low-voltage power	7.401	–	0.050	–	7.451	0.536	7.987
Medium-voltage power	6.578	–	–	–	6.578	0.474	7.052
French Consulate							
Lighting and domestic use							
Saigon-Cholon	8.252	–	0.200	0.110	8.562	0.616	9.178
Gia Dinh-Bien Hoa	8.252	–	0.200	–	8.452	0.609	9.061
Low-voltage power	7.401	–	0.050	–	7.451	0.536	7.987
Medium-voltage power	6.578	–	–	–	6.578	0.474	7.052
US Offices and Installations							
Lighting and domestic use							
Saigon-Cholon	8.252	–	0.200	0.110	8.562	–	8.562
Gia Dinh-Bien Hoa	8.252	–	0.200	–	8.452	–	8.452
Low-voltage power	7.401	–	0.050	–	7.451	–	7.451
Medium-voltage power	6.578	–	–	–	6.578	–	6.578

TABLE IX-2

Provincial Electricity Rate per Kilowatthour for Each Class of Supply Except the Centers of An Giang, Ba Xuyen, Ban Me Thuot, Binh Duong, Dalat, and Song Pha

(Reference: Decree No. 401/CC/UBTIQG March 29, 1971)

Type of Electricity Supplied	Basic Rate Per kWh	Registration Fee 2.88%	Plant Renewal Fund	City Tax	Total	Prod Tax 7.2%	Total Per kWh
	VN$						
General Public							
Lighting and domestic use	15.00	0.43	0.20	–	15.63	1.13	16.76
Low-voltage power	13.50	0.39	0.05	–	13.94	1.00	14.94
Medium-voltage power	12.00	0.35	–	–	12.35	0.89	13.24
Administration							
Lighting and domestic use	15.00	–	0.20	–	15.20	1.09	16.29
Street lighting	12.00	–	0.20	–	12.20	0.88	13.08
Low-voltage power	13.50	–	0.05	–	13.55	0.98	14.53
Medium-voltage power	12.00	–	–	–	12.00	0.86	12.86
Electricity Rate Applied to the Below Provincial Centers							
An Giang Cooperative	9.74	–	–	–	9.74	–	–
AN GIANG							
General Public							
Lighting and domestic use	15.00	0.43	0.20	1.00	16.63	1.20	17.83
Low-voltage power	13.50	0.39	0.05	0.25	14.19	1.02	15.21
Administration							
Lighting and domestic use	15.00	–	0.20	–	15.20	1.09	16.29
Street lighting	12.00	–	0.20	–	12.20	0.88	13.08
Low-voltage power	13.50	–	0.05	–	13.55	0.98	14.53
BA XUYEN							
General Public							
Lighting and domestic use	15.00	0.43	0.20	–	15.63	1.13	16.76
Low-voltage power	13.50	0.39	0.05	–	13.94	1.00	14.94
Administration							
Lighting and domestic use	15.00	–	0.20	–	15.20	1.09	16.29
Street lighting	12.00	–	0.20	–	12.20	0.88	13.08
Low-voltage power	13.50	–	0.05	–	13.55	0.98	14.53
BAN ME THUOT							
General Public							
Lighting and domestic use	15.00	0.43	0.20	–	15.63	1.13	16.76
Low-voltage power	13.50	0.39	0.05	–	13.94	1.00	14.94
Administration							
Lighting and domestic use	15.00	–	0.20	–	15.20	1.09	15.29
Street lighting	12.00	–	0.20	–	12.20	0.88	13.08
Low-voltage power	13.50	–	0.05	–	13.55	0.98	14.53
Medium-voltage power	12.00	–	–	–	12.00	0.86	12.86
DALAT and SONG PHA*							
General Public							
Lighting and domestic use	6.877	0.198	0.200	0.200	7.475	0.538	8.013
Low-voltage power	5.731	0.165	0.050	0.050	5.996	0.432	6.428
Administration							
Lighting and domestic use	6.877	–	0.200	0.200	7.277	0.524	7.801
Street lighting	4.585	–	0.200	0.200	4.985	0.359	5.344
Low-voltage power	5.731	–	0.050	0.050	5.831	0.420	6.251
Water pumping use	4.585	–	0.050	0.050	4.685	0.337	5.022

*Song Pha applied the listed rate without the city tax.
Reference: Decree No. 402/UBTIQG March 29,1971

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based on size and type of lamps.

MST also recommended that the use of the present complicated formula be eliminated but retaining, for the time being, the rate differentials presently existing, with the overall rate level determined on the basis of a "reasonable rate of return".

Block-type rates should not be adopted at this time, although they should be eventually. If block-type rates were adopted at the present time, rates to small users would have to be increased substantially. When overall rate levels can be reduced, block-type rates determined on a cost-to-serve basis should be established to promote additional sales.

In the meantime, rates should be based on the actual relationship of revenues, expenses, and net plant in service as shown by actual operations. This is advantageous, since the present relative importance of the various factors can be identified but can only be estimated for the future.

NPS has reviewed the work done by MST and concurs in its conclusions.

MST has also suggested changes in billing procedures to enable VPC to make bill analyses and classify customers according to various blocks of usage.

Some 7500 or more small users having lighting and air conditioning, which are billed at the same rate, have two meters and receive two bills. They can and should be served with one meter. Some 5000 additional customers having lighting and low-voltage power now served through two or more meters should also be served by one meter when a combined rate has been established.

Consequently, VPC must begin to accumulate data based on the principle that all service to a single customer at a single location will be served through a single meter, so that the necessary data required for proper rate design will be available when the time comes to adopt block-type rates.

For cost-to-serve studies, VPC must accumulate the necessary detailed statistics on net plant in service, production, transmission and distribution, and detailed operating and maintenance expenses, together with data on the load profile of the various classes of service. This must be done in order to properly allocate plant investments and expenses to customer costs, facility (demand) costs, and energy costs.

Initially, VPC will have only two classes of service:

1. Low-voltage lighting and power (monophase or triphase).
2. Industrial power.

Sometime in the future, VPC may wish to differentiate between domestic and commercial service.

In connection with the design of block-type rates, it should be noted that the basic philosophy involved is that incremental costs are considerably less than average costs. For example, the minimum and beginning blocks of residential rates are designed to cover customer costs, facility (demand) costs, and average energy costs with the lower end step covering the incremental energy costs. Customer costs include the costs of meter reading, billing and collecting expenses, operation and maintenance of service drops and meters, and return on investment in services and meters. Facility or demand costs include the return on allocations of production, transmission and distribution plant required to serve the customer's demand, and allocations of operating and maintenance expenses. In general, these costs must be covered regardless of the energy consumed by the customer. Average energy costs include the return on allocations of production, transmission and distribution plant required to serve the customer's energy load, and allocations of operating and maintenance expenses. However, incremental energy costs are considerably lower, the return on plant has already been covered, normal operation and maintenance have been covered, so incremental costs in general become merely fuel costs plus some added maintenance except where such so-called incremental sales add to system peak, require additional plant investment, or produce increased losses.

It must be emphasized, that in an inflationary economy with fixed plant values, it is entirely possible for incremental costs to approach, or even exceed, average costs. This effect can be largely offset by re-evaluating plant in service to a present fair value basis. However, care must be exercised so that initially designed end steps are not too low, thus necessitating later rate increases rather than continuing rate reductions.

Initially, it is suggested that the primary cost-to-serve studies should be limited to large industrial service to encourage connection of industrial loads to the VPC system. In Vietnam, a large number of industrial loads are being supplied with their own generation. VPC should be able to supply central station service to such customers at lower cost than they can provide their own service. A properly designed industrial rate structure should rectify the situation as long as the quality or reliability of the service provided is equal to or better than self-generated loads now enjoyed.

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SECTION X
NATIONAL UTILITIES COMMISSION

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SECTION X

NATIONAL UTILITIES COMMISSION

The MAT study of August, 1967 recommended the establishment of a separate utilities commission having three members appointed by the President of Vietnam. It was to have its own staff with general powers to investigate and review the activities and programs of electric utilities but with only specific and limited regulatory authority. The principal area in which this commission was to be granted such authority was in the regulation of rates. The commission would fix the rates, subject to judicial review.

NUC was established by the Prime Minister of Vietnam by a Decree dated September 23, 1968. A translation of this Decree appears at the end of this Section.

Article 1 of the Decree provides for the commission to be an agency within the Ministry of Public Works.

Article 2 provides that the commission shall consist of three members appointed by the Prime Minister with staggered terms of six years each. The Prime Minister also appoints the Chairman of the commission. Any member may be removed by the Prime Minister if he is unable to perform his job in a satisfactory manner, is negligent in his duties, or has committed a crime.

Thus, the commission is not the completely independent commission contemplated in the MAT report.

Article 3 prescribes, in general, for the internal organization of the commission and necessary experts. It also requires that expenses of the commission are to be borne by the national budget. These provisions are in conformity with the MAT recommendations, except it was expected that an independent commission would determine its own budget.

Article 4 taken with Article 1 as related to control of concessionaires, prescribes the "functions and powers" of the commission. No provision is made for NUC to appoint arbitrators to determine the price to be paid by utilities for necessary land or land rights when the parties at interest cannot agree. It does provide that the commission may seek assistance from the courts in regard to its decisions.

Article 5 provides for the promulgation and manner of determining rates and also provides that if a utility does not want to accept a decision of the commission, it may appeal to the courts.

Article 6 provides for such matters as accounting procedures, classification of accounts, invested capital, depreciation and amortization, safety regulations, construction standards, and quality of service.

Article 7 provides for applications for franchises.

Article 8 provides for the commission to take over the powers and records of the SOC relating to the takeover of franchises, etc.

In order to assist the commission in its formative period, USAID has provided for advisory services under a one–year contract for 1971. Information obtained from the advisor's reports and discussions with him and the Chairman of NUC have been utilized in reviewing the present state of the commission's development and in assessing its role on the viability of the electric utilities of Vietnam. Information has also been obtained from the USAID audit report dated September 30, 1971.[1]

NUC is a very new agency and is in an evolutionary process of becoming a distinctly GVN institution and not in the classical concept of a regulatory body as in the US.

It is not a truly independent body. Given the fact that the principal electric utility in Vietnam is owned by GVN, it follows that NUC might be expected to operate less freely toward VPC than if VPC were privately owned. Yet, the NUC seems to exercise, to a great extent, the basic freedoms of independent decision and action which are clearly embodied in its charter as set forth in the Decree. More assurance in this respect could be gained if NUC were further removed, and consideration might well be given to attaching NUC to the Prime Minister's office.

In its formative or procedural aspect, it is developing regulatory procedures, definitions, and precedents and also a statistical body of experience and knowledge to utilize in the rates and regulations processes and decisions.

It is seriously lacking in sufficient capable professional staff personnel qualified for career

[1]Area Auditor General/Vietnam, *Report on Final Examination of United States A.I.D. Mission to Vietnam (USAID/VN) Contract No. AID/vn-14 Between Vietnam Power Company and Commonwealth Associates, Inc. (Project No. 730–12–220–356, Vietnam Power Company) For the Period from October 11, 1967 to August 31, 1971.* Audit Report No. 9–730–72–23. USAID, September 30, 1971.

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development in the field of utility regulation and the increasing needs of NUC.

It suffers from inadequate finances to attract high-quality staff personnel and to support its expanding needs for inspections and investigations of utility operations throughout Vietnam.

Increasingly, NUC is given special tasks which are usually assigned to an operating agency. One example relates to a USAID program for rural cooperatives in which the Chairman of NUC is assigned as project manager for the program and custodian of certain funds and other responsibilities. A discussion of the program, in detail, will be found under Section VI.

In October 1971, the Chairman of NUC, under the authority of the Minister of Public Works, invited proposals from engineering firms to make a feasibility report on power system developments for the cities of Da Nang and Nha Trang and environs.

The use of a regulatory commission for the above purposes is unusual. It uses the commission as an operating agency which is outside its proper role as a quasi-judicial body.

One might suppose that the Minister of Public Works would have made the assignments to an operating division in his Ministry. However, aside from VPC, no other electrical operating agency is available and, hence, the convenient use of NUC is understandable.

It is pointed out, however, that the practice of using NUC as an operating agency, or giving the Chairman operational duties, dilutes the effectiveness of NUC as a regulatory body and, it is recommended that as soon as practicable, such assignments be handled outside NUC.

In assessing the role of NUC in the development of utilities in Vietnam, the following points should be taken into consideration:

NUC provides for an independent or separate review of utility operations that could assure more efficient management and operating practices and equable service practices.

The regulatory lag in rate changes necessary for the financial integrity of the utility has been greatly reduced. There has been a vast improvement over the performance of the former interministerial SOC which could never have accomplished the rate decisions handed down by NUC in so short a time.

NUC has inherited various residual controls from other former GVN regulatory or administrative agencies and is absolving or adjudicating them in its revisions of franchise agreements.

Standards for uniformity in systems of utility accounts, depreciation techniques, rate base methods, etc., within its regulatory authority are being established.

NUC assures a fair rate of return on utility investments and provides for adequate capital reserves for expansion.

The utilities are enabled to re-evaluate rate base and depreciation without being in direct conflict with established law.

NUC is responsible in protecting and representing the public and national interest in utilities.

It is responsive to the Utilities Committee of the National Assembly. In this respect, it acts as an insulating agency for the utilities which precludes direct interference by government and other agencies with utilities management and operations.

It is reported that NUC is active, dynamic, and enthusiastic in the performance of its duties. As it does the job, it is working, evolving, and learning; establishing rules and regulations and making rate decisions; investigating complaints; protecting the public interest; and prodding the utilities.

Since the beginning of its work in December 1969, NUC has made 11 power rate decisions, 5 water rate decisions, 57 field investigations of provincial power systems, 43 field investigations of provincial water systems, 48 special studies and investigations for the Ministry of Public Works, and 200 other regulatory and procedural decisions.

The audit report of USAID points out that the SOC was found by MAT to have powers which were too extensive and it recommended a separate three-man utilities commission. Members were to be appointed by the President of Vietnam. The proposed commission would have authority to investigate and review the activities of utility companies but would have only specific and limited regulatory authority, principally in the area of rates.

It says further that the September 1968 Decree gave extensive powers to the NUC. As did the SOC, the NUC has extensive powers to control all concessionary companies including agencies managed by GVN, national companies or autonomous agencies operating power systems in all areas of Vietnam; to study rate policy; approve the power rates of all concessionary companies; and to study concessions and propose to GVN on the taking over of concessions, approval of concessions, and fusion or transfer of property of concessionary companies. The audit report concludes that activities of NUC should be restricted to the rate-making area. It should be

noted that the authority of regulatory agencies in the US is not restricted solely to rate making. It is not considered that the powers of NUC are too extensive.

The audit report is concerned that VPC pays part of the expenses of NUC. In the US, regulated utilities in many states pay fees to the regulatory commission.

The relationship of NUC and VPC, both being under a single administrative head, is unusual. Both are GVN agencies and a common administrative head is inevitable. NUC has the benefits of the courts as does VPC. However, the exercising of these rights does not seem practical in a real sense considering that both agencies are sensitive to the interplay of politics.

The balance between VPC and NUC, at the present time, should not be detrimental to the best interests of either agency. The Minister of Public Works is the cabinet officer responsible for an ample supply of electric power for all of Vietnam at the lowest practicable rates. To meet this objective, it should be expected that any minister will utilize the operating utility and the regulatory agency in ways which he believes will best meet the needs.

NUC provides an agency separate from VPC where customers of VPC may file complaints and be heard.

NUC will have a far-reaching effect on the future power development in Vietnam. At the moment, it is operating with sufficient freedom to be an effective agency and has developed an acceptable image.

It could have an important effect on VPC's credit rating. To the extent that NUC does its work independently and arrives openly at rates sufficient to permit VPC to reach its objectives of sufficient power at lowest practicable rates with balanced rate schedules, it can have very beneficial effects.

It could be an important force in monitoring, or auditing, the performance of VPC, particularly in the field of accounting procedures and rate studies.

NUC is still in the early stages of its development and continuing advisory and specialized support can be helpful.

TRANSLATION OF DECREE No. 131/SL/CC/GTVT DATED SEPTEMBER 23, 1968

General functions of the National Utilities Commission:

Article 1 – The National Utilities Commission is set up at the Ministry of Public Works, with following functions:

- Control of concessionaires including government-owned companies and autonomous agencies which distribute water and electric power throughout Republic of Vietnam.
- Study and determine power and water rates for all concessionaires.
- Issue common or special specifications, for power or water supplying.
- Examine and propose to the government all measures related to concessions for distribution of water and electric power.

MEMBERS OF THE COMMISSION

Article 2 – The National Utilities Commission consists of three (3) members and one Secretary General.

All members will be appointed by the Prime Minister.

Of those initially appointed, one shall serve two years, one four years and one six years.

At the expiration of these terms, all members of the commission subsequently appointed, who may be those persons then or previously holding the office, shall serve for a term of six years.

The Prime Minister shall appoint a commission chairman from its membership who shall serve for two years. At the expiration of each two-year term, the chairman shall be selected again who may be the person then or previously holding that office.

During this term of office, a member is not allowed to assume another function. Exceptions to this will be made only upon approval of the Prime Minister.

A member would be removed by the Prime Minister due to inability to perform the job in a satisfactory manner, negligence of his duties,or crime commitment.

The commission Secretary General will be selected and appointed by the commission.

ORGANIZATION

Article 3 – The Secretary General will be responsible for the execution of commission

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instructions and for conducting the Current Affairs Section and the Experts Section.

The Current Affairs Section is responsible for keeping files and minutes of the meetings of the commission.

The Experts Section is responsible for the execution of all duties trusted by the commission to the Secretary General, i.e., reviewing records, contracts, files, and documents of concessionaires. This section consists of inspectors, controllers, accountants, lawyers, engineers . . .

The Secretary General will have to prepare annual budget necessary for the commission activities.

All commission expenses will be borne by the National Budget and expenditure procedures will be determined by a Decree of the Public Works according to proposals of the commission.

FUNCTIONS AND POWERS OF THE COMMISSION

Article 4 – The functions and powers of the commission shall be to:

- Require and receive annual reports in the form specified by it regarding the operations, plans, and financial results of concessionaire.
- Review such reports to determine whether the concessionaires have properly fulfilled their functions and are prepared to do so in the future.
- Conduct investigations on power or water rate and on the implementation of technical standards, either at the initiative of the commission or at the request of a government agency or of a customer.
- Examine power or water rate proposed by concessionaires.
- Examine the application for concession, authorize the merger or sale of electric utilities.
- The commission can get support from the courts when making a decision. If any utility does not accept a commission decision, the issue may be appealed to the courts.

POWER AND WATER RATE

Article 5 – By virtue of the mandate, the Minister of Public Works and Communication and Transportation vested in the power or water rate that is applying for each concessionaire will be fixed and promulgated by the commission.

There is no power and water rate, or changement on the power and water rate that can be applied until the commission agrees and promulgates.

The way to calculate the power and water rate will be fixed by the commission's details depending on the management of a concessionaire.

In case the concessionaires don't accept the commission decisions, they have the authority to bring the matter to the court for the judgment.

FRANCHISE SPECIFICATIONS ON OPERATION

Article 6 – The commission will review, approve and promulgate common or special specifications.

In each specification, accounting procedures and technical standards will be fixed.

From the accounting point of view, the commission will determine the classification of accounts, the invested capital, the depreciation and amortization . . .

From the technical point of view, the commission will determine the safety regulations, the construction standards, and the quality standard for services.

Regarding the above-mentioned points of view, the concessionaires' operations will be followed up by the commission.

Besides the audit of the commission, all concessionaires are still under the control of financial regulations in force.

APPLICATION FOR CONCESSION

Article 7 – All applications must be forwarded to the commission in which the availability of funds, the development programs, estimated rates must be stated.

After reviewing and discussing, the

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commission will propose to the Minister of Public Works to reject or to accept an application.

EXAMINATION AND TAKE-OVER CONDITIONS

Article 8 – While waiting for the specifications and the formulas to compute the power or water rate issued by the commission, concessionaires can continue to operate according to specifications being approved.

To carry out its functions, the commission will take over the powers and the archives of the Service of Control established by Decree No. 238/BCC/NV/ND dated September 14, 1965.

The commission will represent the Committee of Price in the determination of power rate.

Any provision which is contrary to the spirit of this Decree is not effective.

Article 9 – The Minister of the Prime Minister Office, the Minister of Public Works, the Minister of Economy, and the Minister of Finance are charged each as to that which concerns him with the execution of this Decree.

This Decree will be published in the official journal of the Republic of Vietnam.

Saigon, September 23, 1968

/s/TRAN VAN HUONG

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SECTION XI
ORGANIZATION

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SECTION XI

ORGANIZATION

EXISTING SITUATION

The merging of SPC and EOV in 1969 into VPC presented the new company with major problems of organization in combining the staffs of the two companies.

Anticipating this, the MAT study devoted a great deal of attention to the matter. It recommended an interim organization for SPC when SPC took over CEE, and suggested a possible initial phase relationship between SPC, EOV, and a proposed MST. This was to provide a way in which SPC and EOV would operate together pending their consolidation into VPC. After consolidation, MST was to continue and assist VPC in its organizational and operational problems, and VPC was to be organized along the lines shown in the MAT report, Figure XI–1.

The SPC took over the facilities of CEE on January 1, 1968, and EOV continued to operate as a separate entity until December 24, 1968 when the Prime Minister approved a decree to merge the properties of EOV into SPC within 12 months' time. On January 1, 1970, two years after the target date, the two companies were merged and renamed the Vietnam Power Company. However, the predecessor companies continued to operate more or less independently until mid-1970 when the Minister of Public Works was appointed Chairman of the Board.

Initially, VPC did not adopt the line type of organization recommended by MAT but instead operated under the "committee" type organization shown on Figure XI–2.

MST continued to work on organizational problems with VPC. When NPS arrived in mid-May 1971, it was asked for organizational advice on an informal basis by the Chairman of the Board particularly with respect to the planning function. In responding to this request, NPS, also suggested that a line type of organization be adopted by VPC.

MST, in its final report dated August 1971, said:

> "It takes time and patience to merge two operations because of the difficulty of finding, training and developing the specialized personnel. As rapidly as possible responsibility should be delegated and authority provided to carry out assigned duties terminating the management committee concept. Duplicated responsibilities and activities should be consolidated."

The NPS Team concurs in this recommendation. On September 2, 1971, VPC adopted the organization shown on Figure XI–1.

VPC is now organized into three principal departments: two area or regional departments and a general administrative department each headed by a vice president and an engineering division headed by a manager.

In this new organization, the engineering function reports directly to the president as recommended by MAT. It is headed by a manager instead of a vice president. An electric utility is a highly technical enterprise and its engineering department is very important. It should have a vice president in charge who has technical ability and proven management ability.

A separate rate section should be organized and given the immediate job of making a complete rate analysis and review as a basis for the development of a rate structure which will encourage industrial development in Vietnam. Any tendency or temptation to view the NUC as a rate analysis service for VPC should be rigorously discouraged.

Customer service, including new connections, customer relations, sales promotion, and cash collection for the Saigon metropolitan area have been put under the Transmission and Distribution Department.

Customer service is very important and should be a separate department. It is a completely different type of function and does not belong in the same department with transmission and distribution operations.

The separate planning unit shown is the result of the advice given in June 1971 to the Chairman of the Board by NPS in response to his informal request. It is not intended to be permanent.

VPC is very new and still has a long way to go before it can be considered a seasoned and sophisticated utility in all its aspects. Its planning, in a corporate sense, is yet to be developed. Top management, including the Chairman and the President, must be intimately involved in this development. The planners will need all of their

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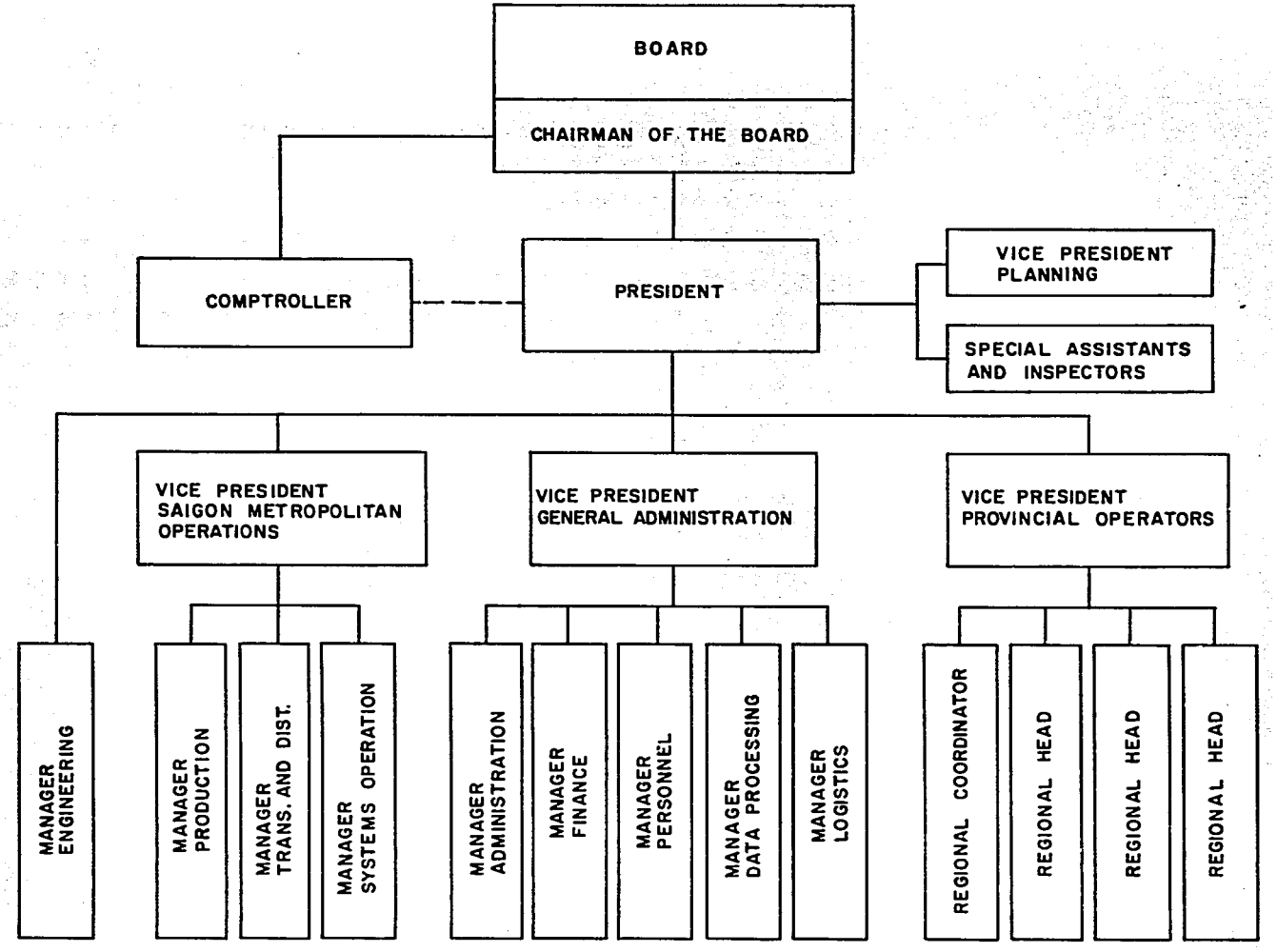
FIGURE XI-1

VPC "LINE" ORGANIZATION RECOMMENDED



time for planning, and their effort should not be diluted by being also concerned with day-to-day operating problems.

VPC has an unusually large system development ahead of it. It will require huge amounts of money, and it will need to acquire and train the people who will be needed to operate the rapidly expanding and nation-wide system. These areas represent, today, its most vital matters of concern and should be given concentrated attention.

At the time response was made to the Chairman's request for advice on the planning function, VPC had the committee management organization shown on Figure XI-2. Engineering and provincial operations were grouped under one commissioner with the result that the head of the group was almost overwhelmed with day-to-day operating details relating to the provinces and the many matters pertaining to the engineering function. The provincial operations extend to all areas outside the Saigon metropolitan area from one end of Vietnam to the other. This job requires considerable travel, dealing with public and customer problems, operation and maintenance of generation, transmission and distribution, collection of bills, service to individual customers, storing and issuance of materials and supplies, and many other associated activities.

The engineering division with responsibilities for engineering matters, such as planning, design, drafting, maps and records, rights of way, and outside contracting has nothing in common with provincial operations in its day-to-day work. The work is of sufficient importance and large enough to demand the full time of its manager or director.

It was apparent that the planning effort could not receive the concentrated attention it required. For this reason, it was recommended that the best system planning engineer the company had should be divorced from day-to-day operating and administrative duties and set up in a small separate planning division reporting directly to the president.

In addition to the demands for system planning, there is an acute need for financial planning – currently and in the future.

Personnel planning also needs special attention. An important consideration to which VPC must devote considerable attention is in the number of persons now employed which is reported as a total of 4286 as of March 1971. Dividing this number into the total generation for 1970 of 986 000 kWh results in about 200 kWh of total generation per employe.

The Taiwan Power Company annual report for 1970 shows 11 402 employes and an employe-generation ratio of 1204 kWh per employe. The present installed capacity in 1970 on the Taiwan Power system was 2720 MW. The load projection for VPC in 1986 is 2680 MW. Thus, the VPC system in 1986 will be about the size of the Taiwan Power system in 1970.

To do as well as Taiwan Power, VPC would have to limit its total employes in 1986 to about the number employed by Taiwan Power in 1970 or 11 000 employes.

It is suggested that VPC endeavor to do better than Taiwan Power and that a rigorous program giving careful consideration to the number of people added to the payroll be instituted with a view of increasing the productivity of each employe by over sixfold in the 15 years to 1986. The history of successful utility companies is a constant increase in productivity per employe with growth in generated kilowatthours. The rate of growth of productivity is a very important factor in keeping rates as low as possible and in keeping a good credit rating.

VPC is short of power, in great need of funds and credit, and short of trained and experienced personnel in many areas despite the fact that it has a relatively large number of employes.

Therefore, it was recommended that the special planning group be formed. This arrangement was intended to be only an interim arrangement until such time as an organization like the MAT proposal for VPC is in effect and experience is gained, particularly in the areas of finance and personnel.

There are other functions for which planning must be done and which require top corporate attention, such as public and community relations, new business, industrial development, environment, and others and all are important.

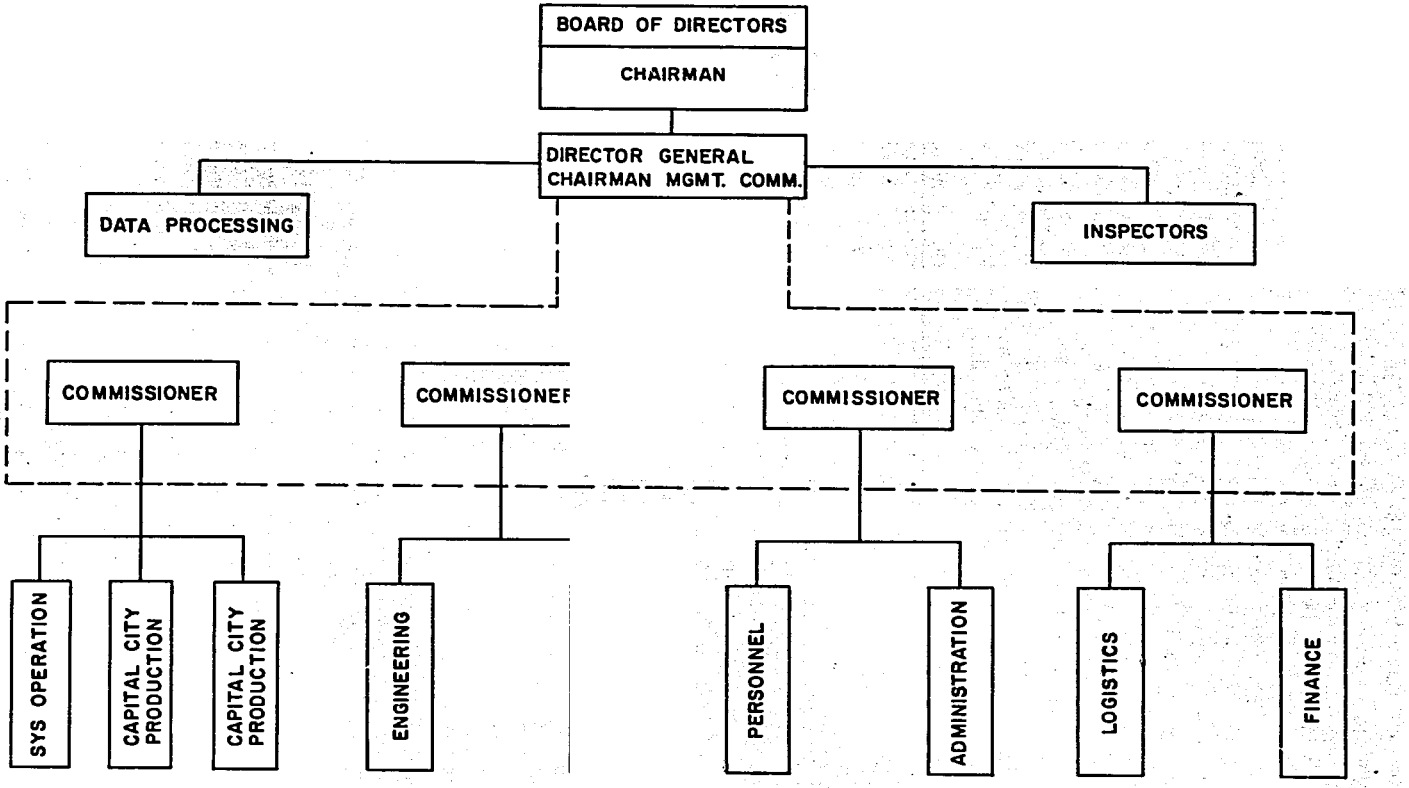
An organization such as that proposed by MAT has all the necessary elements included on a function basis and with each principal function having its own vice president or manager.

Thus, one person is not required to closely supervise on a day-to-day basis dissimilar activities and overloading of the individual is avoided. Under such arrangement, time is available to devote to planning under the particular function.

For example, system planning, economic, and feasibility studies for generation, transmission, and distribution can be done in the engineering division and receive the necessary amount of

FIGURE XI-2

VPC "COMMITTEE" TYPE ORGANIZATION BEFORE SEPTEMBER 1971



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attention from the engineering head.

A capable comptroller can handle the financial planning function under his division. But first he must be available. At the present time, VPC has no qualified man with experience in planning financial strategy. By including this function initially in a separate planning division, undivided attention can be given both financial planning and the development of a qualified individual. Presently, this is one of VPC's most pressing personnel needs.

In like manner, emphasis is given the personnel problems in VPC. Detailed planning for personnel requirements, training, and procurement can receive concentrated attention and the planning individual gain in training and experience.

When the organization suggested by MAT is in effect and the special planning department disbanded, the vice president in charge of engineering will be the principal system planner; the comptroller, the principal financial planner; and the director or manager of personnel, the principal personnel planner. In these roles, all serve as staff advisors to the president in the area of planning.

Usually, a utility president will call in his department heads and outline the particular planning need. If the main task is working up a financial plan, the president will give the financial planner the responsibility for producing a financial plan and request the others to give him all the assistance needed from their respective departments.

If, for example, planning is asked for in-system expansion and the preparation of a feasibility study, responsibility is given to the head of engineering. The other departments cooperate and assist with necessary financial accounting, rate, operation data, and other information needed to produce the feasibility study.

If the principal area is in personnel, the head of personnel is given the responsibility and the other departments support and assist him.

The present VPC organization does not reflect the final consolidation of SPC and EOV. It is time that this should be accomplished.

After careful review, study, and consideration, NPS confirms the organization as proposed by MAT in its 1967 report, and it is adopted as part of this report.

PROPOSED ORGANIZATION

Responsibility and Authority

The organizational and functional structure of VPC (see Figure XI–3), is based upon the principle that delegated responsibility must carry with it equivalent authority. The Board should delegate to the President and General Manager the responsibility to manage the company as well as the necessary authority to discharge this responsibility. The Board must act through the President and not independently. This is very important if the company is to operate effectively.

When the President delegates the responsibilities indicated in the functional charts in this section to the engineering, operating, or other departments, he must also delegate the authority to carry out these functions.

The above principle extends down to the lowest rung in the management ladder and should be impressed upon every level of management.

After responsibility and the corresponding authority have been delegated, management must supervise to be sure that the delegated responsibility is fulfilled. The next higher level of supervision is directly responsible to see that the delegated responsibility is carried out and that the delegated authority is properly used. Often it is easier for a supervisor to do a job assigned to a subordinate than to see that the subordinate does it properly. However, if a supervisor does the work assigned to a subordinate, he is not supervising properly. This responsibility goes on up the ladder of management to the top. Each level of authority must know that the functions are being properly carried out and this can be known only by systematic reporting and review of results and by various other forms of performance controls.

Responsibilities and Qualifications of Management Personnel

Board of Directors

The Board of Directors determines the policies which are to be carried out by the President and General Manager but does not assert or exercise direct control over the company's operations. It will act through the President in all matters and will devote its attention to policy rather than operating details. The Board will have a set of by-laws prepared to guide its procedure.

The Board will select a Corporate Secretary who will be responsible for keeping minutes of all board meetings and all other corporate records.

The Secretary, in cooperation with the President and the Chairman of the Board, will prepare an agenda for each meeting of the Board of Directors and will notify stockholders of meetings.

President and General Manager

The President and General Manager is selected by the Board of Directors for a fixed term (suggested as not less than five years) and shall thereafter continue in office until he resigns or is removed by the Board.

The President and General Manager should have demonstrated executive ability and, if possible, have extensive experience in electric utility management and operations. Sound executive ability and experience are of first importance, however. He will have the responsibility for determining company policies, subject only to approval by the Board, and for operation of the company in accordance with those policies. He is the chief executive of the company and will be held responsible by the Board for its efficient operation.

Vice President – Engineering

The Vice President–Engineering, will be responsible to the President for all engineering functions of the company, as outlined on the functional chart for the Engineering Department. He should be selected for his technical ability and his proven management ability. It is also important that the man selected for this position be able to cooperate with others who will carry out the engineering policies established in the Operating Department, the regional departments, and elsewhere.

Vice President – Operating

The Vice President–Operating, should be selected for his ability to manage as well as for his particular experience and ability in the operation of an electric utility. The Operating Department will include the Production Division, the Transmission and Distribution Division, and the Dispatching Division. He will have broad responsibilities for maintaining continuous and adequate service to customers. In the Saigon metro area, he will carry out these functions directly in cooperation with the Vice President–Saigon Metropolitan Area. In the provinces, he will act primarily in a staff capacity as far as direct operation of isolated generating plants and distribution system is concerned.

VIETNAM POWER COMPANY

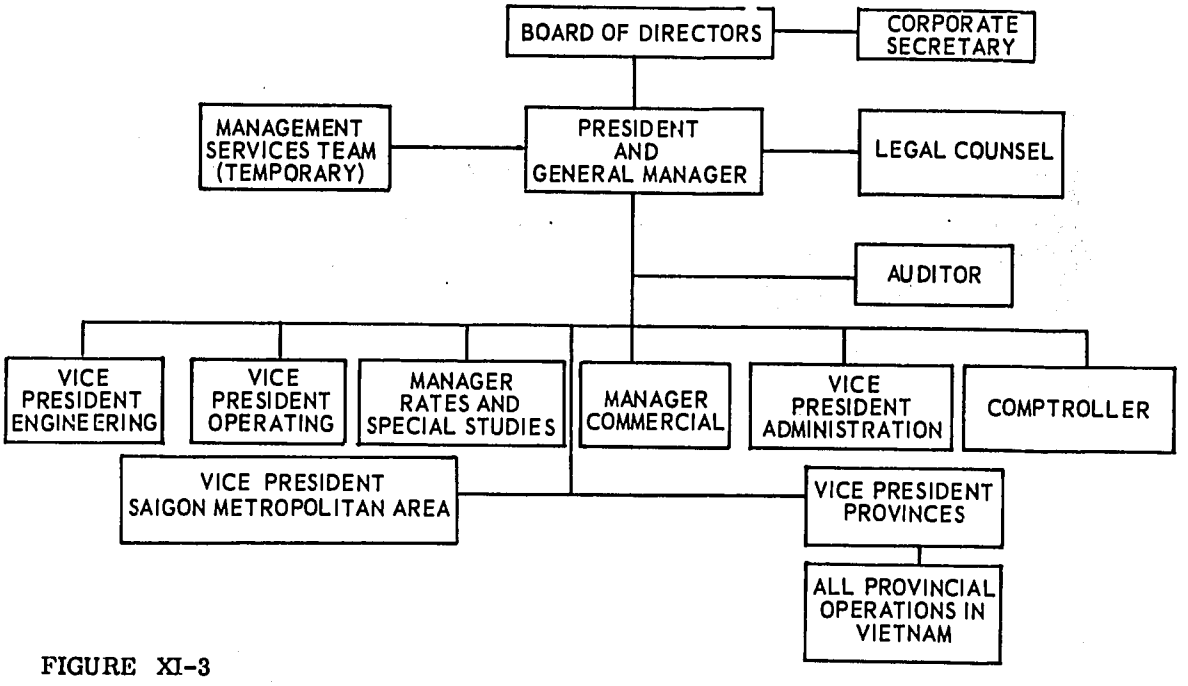

FIGURE XI-3

Manager of Rates and Special Studies

The Manager of Rates is responsible to the President for the planning, design, and administration of rate schedules for the company. He should see that rates are maintained and changed when necessary to produce revenues which will cover all operating expenses and yield sufficient income to support and attract the capital needed by the company. He should also design the rates so that they will distribute the total cost of service fairly among customers with different characteristics of use and encourage increased usage of electricity by customers when the capacity to supply it is available. He is responsible to see that rates are uniformly applied throughout the company. He is responsible for company relations with the NUC.

He is also responsible for all special economic studies for the company. Many of these will be made in conjunction with the Engineering Department and other departments of the company.

The man selected for this position must be well-grounded in engineering and economics and have some knowledge of accounting and the legal procedures involved in utility regulation. He must also have a broad background and knowledge of the entire utility operations. A sympathetic understanding of commercial problems and of industrial development would also be helpful.

Manager of Commerical Department

The Manager of the Commercial Department is responsible for customer relations with the assistance and cooperation of all employes of the company.

The Commercial Department Manager is responsible for the planning and, to a large extent, the execution of plans for industrial development. He is also responsible for the education of customers on the most efficient and best use of electricity and, when capacity justifies, the promotion of the use of electricity.

The actual execution of many of the plans prepared by this department will be carried out by the regional vice presidents and other staff departments. The man selected for this position must be able to secure the cooperation of others. He must also have a sound knowledge of the problems involved in developing industries and in improving the communities served by the company.

Vice President - Administration

This department has broad administrative responsibilities. It includes the Secretariat providing various office services, personnel administration, purchasing and stores, and transportation. The Vice President – Administration must first of all be a broad administrator with a good general knowledge of all these functions.

Comptroller

The divisions under the Comptroller of the company handle the financial planning and maintain all financial records for the company, They also are responsible for all accounting functions. They prepare bills and exercise general supervision over meter reading and collections. They are responsible for all corporate funds and assets and record and control all company disbursements. They also maintain records of stores inventories and records of operating properties.

Vice President–
Saigon Metropolitan Area

The Vice President of the Saigon Metropolitan Area is the direct representative of the President in this region. He is responsible for public relations and customer relations in the Saigon metro area. Although the Engineering Department and Operating department are directly responsible for construction and operation, the regional vice president is responsible to see that work is performed with minimum inconvenience to customers and the public. He is responsible for all commercial operations in his region but is assisted by the Commercial Manager and follows policies established by the Commercial Manager. He is responsible for meter reading and collections in accordance with procedures established by the Comptroller.

This man should be selected not only for his ability as a good executive but, of even greater importance, for his ability to deal with people. He is in effect "The Company" to the people in the Saigon metropolitan area.

Vice President – Provinces

The Vice President – Provinces represents the President in the provinces. Through the division managers, he will be responsible for all public and customer relations in the provinces and he will have direct responsibility for operating isolated generating plants and distribution systems, subject to staff supervision from the Engineering and Operating Departments. He will be responsible for all commercial operations in the provinces but is

assisted by and follows policies developed by the Commercial Manager. He is responsible for meter reading and for collections in the provinces in accordance with procedures established by the Comptroller.

The Vice President – Provinces should be selected not only as a good executive but because of his ability to deal with people and his knowledge of conditions in the provinces.

Legal Counsel

The Legal Counsel can either be an attorney employed by the company or an attorney or group of attorneys retained as legal advisors to the President.

The Legal Counsel, in addition to acting as legal advisor to the President, is responsible for the handling of all claims against the company or by the company against others. He is also responsible for legal advice on taxes and on legal problems arising in connection with regulation.

Auditor

The Auditor performs a staff function rather than a departmental function. His main task is periodic review of departmental operations to insure that company policies and procedures are properly implemented. His staff performs routine audits on all revenues and expenditures of the company. He must devise means to check incoming revenues of all kinds to be sure that they properly account for all collections. He also must devise means to check on all disbursements to insure that money is spent as authorized.

He reports directly to the President who is responsible to take action in the event audits indicate improper handling of incoming monies and unauthorized spending of monies.

The man selected as Auditor must have a background in this area but, of equal or greater importance, he must be a man of unquestioned integrity.

Department Functions

The specific functions of each department are discussed and the more important ones are tabulated in chart form in the following pages.

Throughout these discussions it will be noted that cooperation among departments is stressed. Dividing an organization into departments is only for convenience in administration. A small company could function without being divided into departments. In a large company, however, it is necessary to have departments simply to be able to assign technical activities and problems to groups qualified to handle them and to simplify administration.

Such departmental organization of a business creates the necessity for cooperation among departments. It must always be borne in mind that many people may be involved in each undertaking and that everyone is working toward a common goal – to give good service at the lowest practical cost. It is a major responsibility of the chief executive to see that everyone cooperates properly and that the results of all departmental work are directed toward the desired company goal.

Many functions are not included on the following charts simply because they cannot be assigned to any one department. As an example, one problem of a utility company is the control of maintenance materials. The Stores and Transportation Division under the Vice President–Administration actually handles the physical stock of such materials, but the policy as to the quantity level is determined jointly by the Operating, Engineering, Saigon Metropolitan Area, and Provincial Departments. The Comptroller is also involved since he maintains the records.

Engineering Department

This department (see Figure XI–4) is responsible for the planning and design of all physical plant facilities. If the construction is done by outside contract, the department is responsible for the contracting, supervision, and inspection of such construction. When construction is done by company forces, the department is responsible to see that the construction is in accordance with the design and construction standards for which it also is responsible.

In addition, the department is responsible for maintenance of system maps, maintenance of engineering records, and for the preparation of graphic displays. It is also responsible for obtaining rights-of-way and easements. It maintains files having to do with real property and deeds. It also makes property valuations as needed.

In carrying out these responsibilities, it will be necessary to have the cooperation of other departments. This should be of prime concern to the vice president in charge. He, in turn, must see that his department cooperates with other departments when the work of other departments affects that of the Engineering Department.

In carrying out its functions, the department must constantly look ahead. This applies not only

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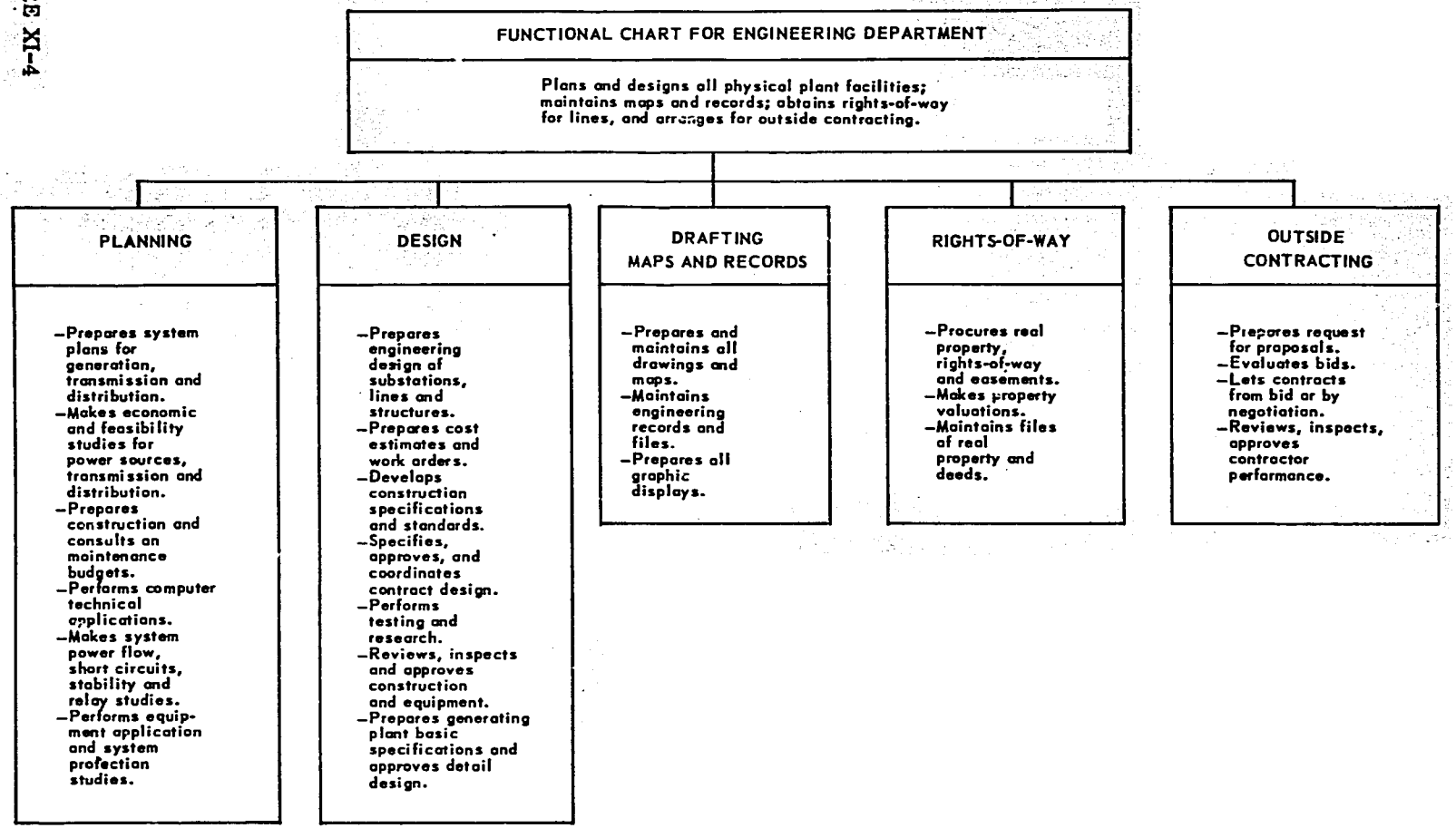
FIGURE XI-4


FUNCTIONAL CHART FOR ENGINEERING DEPARTMENT
Plans and designs all physical plant facilities; maintains maps and records; obtains rights-of-way for lines, and arranges for outside contracting.
PLANNING
–Prepares system plans for generation, transmission and distribution.
–Makes economic and feasibility studies for power sources, transmission and distribution.
–Prepares construction and consults on maintenance budgets.
–Performs computer technical applications.
–Makes system power flow, short circuits, stability and relay studies.
–Performs equipment application and system protection studies.
DESIGN
–Prepares engineering design of substations, lines and structures.
–Prepares cost estimates and work orders.
–Develops construction specifications and standards.
–Specifies, approves, and coordinates contract design.
–Performs testing and research.
–Reviews, inspects and approves construction and equipment.
–Prepares generating plant basic specifications and approves detail design.
DRAFTING MAPS AND RECORDS
–Prepares and maintains all drawings and maps.
–Maintains engineering records and files.
–Prepares all graphic displays.
RIGHTS-OF-WAY
–Procures real property, rights-of-way and easements.
–Makes property valuations.
–Maintains files of real property and deeds.
OUTSIDE CONTRACTING
–Prepares request for proposals.
–Evaluates bids.
–Lets contracts from bid or by negotiation.
–Reviews, inspects, approves contractor performance.

to system planning and better work methods but also to the use of better equipment as it becomes available. This may, at times, require some research when it involves something peculiar to VPC. Primarily, it will simply be a matter of keeping abreast of developments throughout the world and studying their possible application to the particular problems of VPC.

Operating Department

In carrying out the functions of the Operating Department (see Figure XI–5), it will be necessary to have the full cooperation of all departments, particularly the Engineering, Saigon Metropolitan area, and Provincial departments.

The Operating Department will directly operate the generating plants on the interconnected system but will act only in a staff or advisory capacity in respect to the operation of isolated generating plants in the provinces. The local manager will be responsible for the operation and, with staff assistance, for minor maintenance of all generating plants under his control in the provinces. The Operating Department will be directly responsible for major maintenance. The Operating Department is responsible for policy having to do with all generation.

The Operating Department constructs all substation and transmission facilities as well as the distribution facilities in the Saigon metro area, except those which are constructed by contract, and provides staff assistance for distribution construction in the provinces.

Since the regional vice presidents are responsible for customer relations, it is very important that the Operating Department coordinates its work with these departments. This is necessary to assure that the construction, operation and maintenance work is done with the least possible inconvenience to the customers.

All transmission facilities are maintained and operated directly by the Operating Department.

The distribution system in the Saigon metro area will be operated and maintained directly by the Operating Department, but the distribution systems in isolated communities will normally be operated and maintained under the direction of the local manager with staff assistance from the Operating Department. In any event, the Operating Department will establish all policies relative to operation and maintenance of all distribution systems.

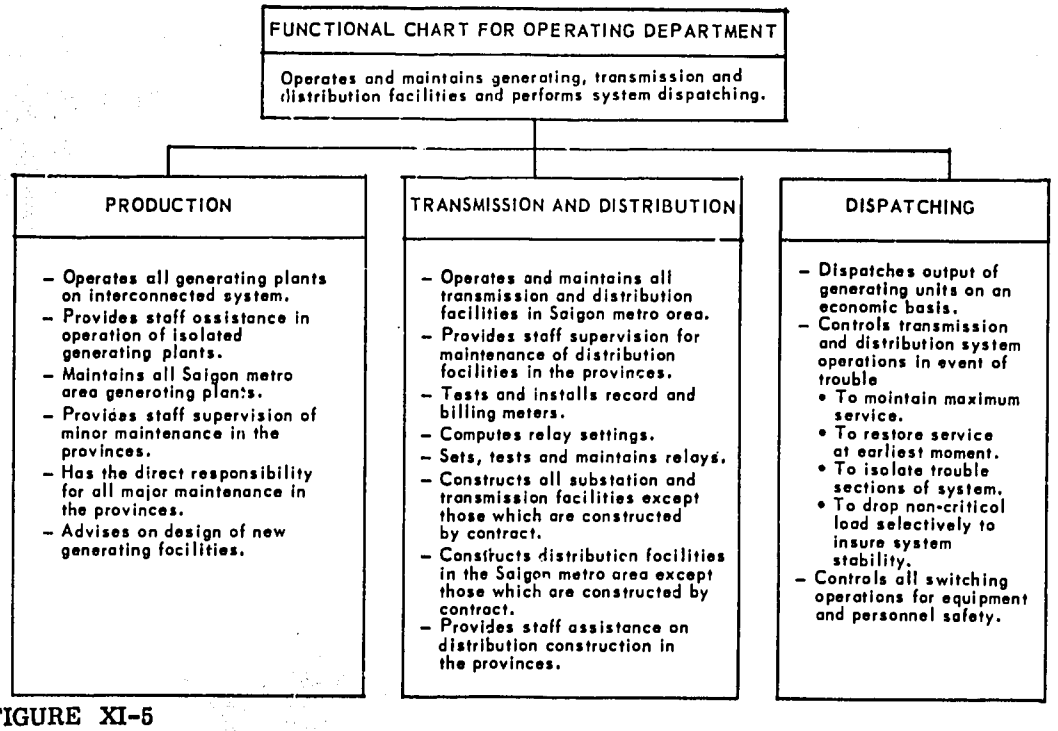


FIGURE XI–5

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Rates and Special Studies Department

This department (see Figure XI–6) has the responsibility for developing and maintaining rates that produce revenues which cover all operating expenses and yield sufficient income to enable the company to finance its capital requirements. It should see that the rates are fair and equitable and are not discriminatory among customers. Also, from time to time, it makes special economic studies.

As a basis for development of rates, it must study customer use records and customer load characteristics. It must determine the cost to serve various types of loads and customers. It must keep these studies current and consistently apply them to the present and future rate structures.

One of the department's immediate functions is to make a complete rate study as a basis for the development of a rate structure which will encourage industrial development in Vietnam. This function should also provide a basis for a continuing study.

In developing a rate plan, this department must look to the future and plan a rate structure that will be most appropriate for the future loads and economic changes anticipated.

The department must work with the Commercial Department, the Saigon Metropolitan Area Department, and the Provincial Department to be sure that rates are applied as intended and that there is no discrimination among customers. In doing this, it should audit the application of rates by the Commercial Department by spot checking from time to time. It is also responsible to see that every customer is on the most advantageous rate for his load.

The department should, with the cooperation of the Legal Counsel, prepare and keep up-to-date contractual forms for all classes of customers. These should be designed for simplicity of application and with customer reaction in mind and should be intended primarily as a basis to provide service to the customer with the least possible inconvenience.

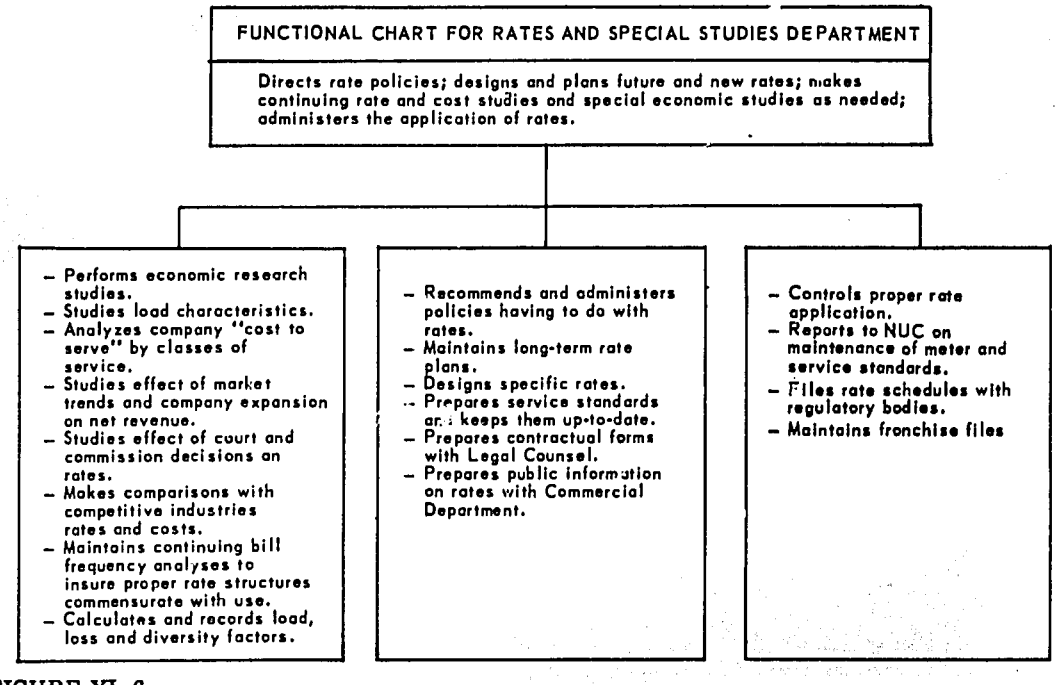

FIGURE XI–6

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Commercial Department

This department (see Figure XI–7), operates primarily in a staff capacity formulating sales policies and sales promotion programs. In publicity and advertising, it generally operates as a line organization. However, when the advertising is in the provinces, the Vice President – Provinces should be consulted.

Initially, sales promotion will be dormant simply because there is no extra generating capacity to sell. Subsequently, sales promotion will become one of the more important functions of this department.

Community and industrial development will be the most important staff function of this department for the next several years. The development should be initiated by government and civic groups, but the power company should play a very active part in the planning and implementation of these community programs.

The Commercial Department should develop the company's contribution to plans for community development and for industrial development, working with the Saigon Metropolitan Area and Provincial Departments and Engineering Department. These plans should be coordinated with governmental plans with the power company being careful to keep itself in the position of helping rather than running the program. It may exert most of the effort but, in order to be effective and enthusiastically accepted, each community must feel that it is its program.

The work involved in helping to carry out these development programs will be in the hands of the Saigon Metropolitan Area and Provincial Departments. The Engineering Department should be kept advised since it must plan facilities to meet the power requirements of any development program.

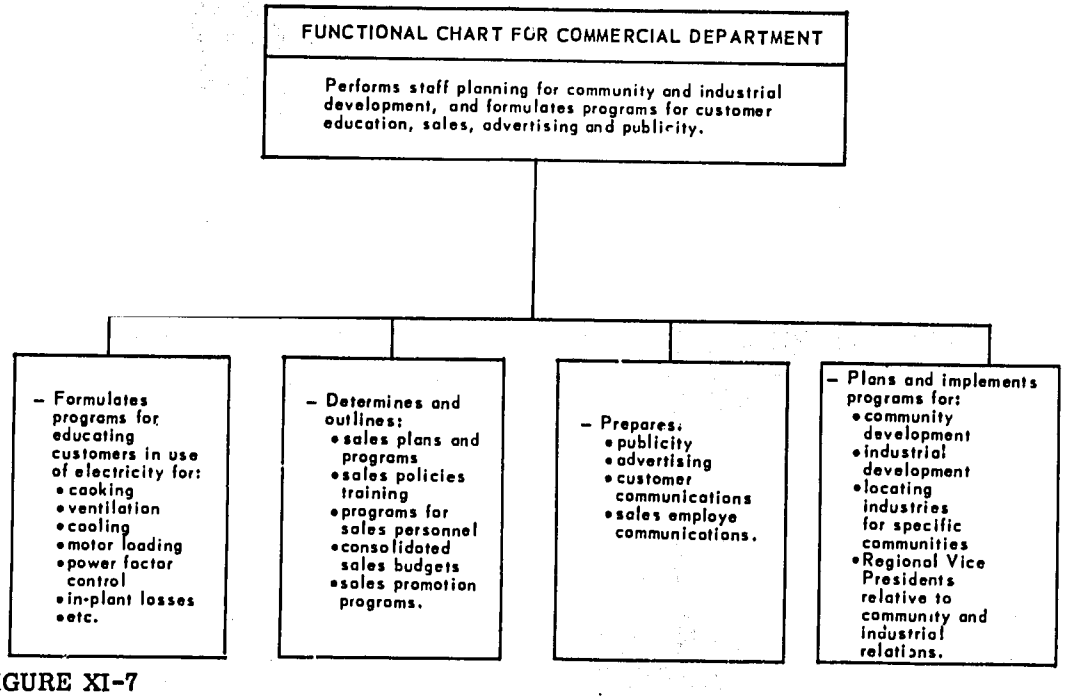

FIGURE XI–7

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Administration Department

The functions of this department (see Figure XI–8), are varied and its effective operation will depend largely on the selection of the right man to head each division.

To some extent, the various functions of this department are unrelated to each other. Personnel is not related to stores and transportation, and office service is only indirectly related to many of the others.

Comptroller

The functions of this department (see Figure XI–9) are well established by tradition and practice. It should be pointed out that meter reading and bill collections will be carried out, in most instances, by others under procedures established by the Comptroller.

In the provinces, the local manager often does the bill collecting personally and meter reading is done by employes performing other services during the remainder of the month. In these instances, the Comptroller exercises control over the meter reading and collection procedures through the Vice President – Provinces.

Saigon Metropolitan Area Department

This department (see Figure XI–10), is responsible for customer relations and public relations in a very important portion of Vietnam. Other departments, particularly the distribution crews, will be in contact with customers but it is the responsibility of the Saigon Metropolitan Area Department to see that these customer contacts are satisfactory both to the customer and to the company. In this respect, it must have the full cooperation of the Operating Department.

In community and industrial development, this department has direct responsibility so far as the company is concerned. The Saigon Metropolitan

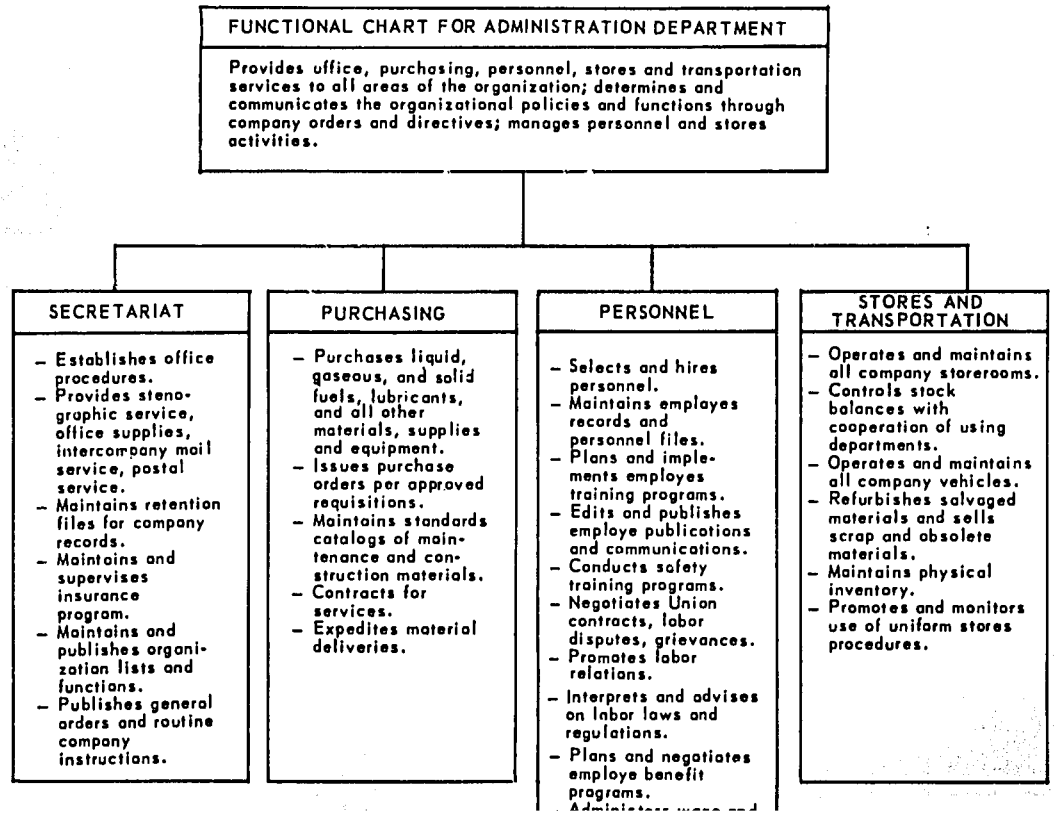

FIGURE XI–8

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Area Department should play a major part in stabilizing and improving the economy of the Saigon metro area. The Commercial Department will prepare the plans and give assistance, but most of the work will be done by the Saigon Metropolitan Area Department.

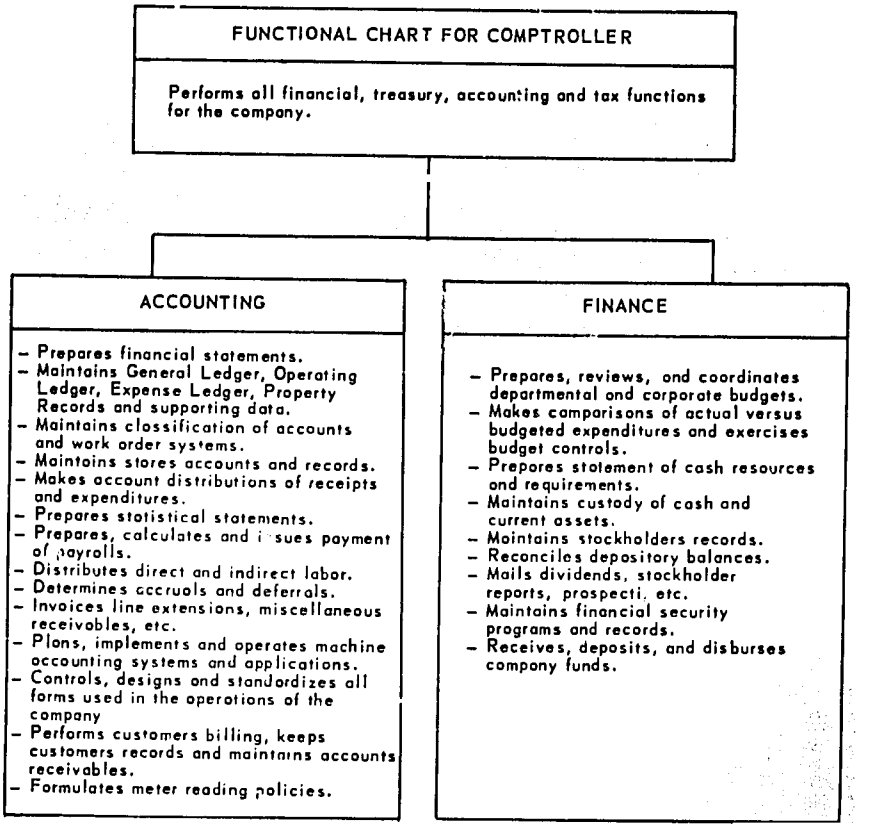

FIGURE XI-9

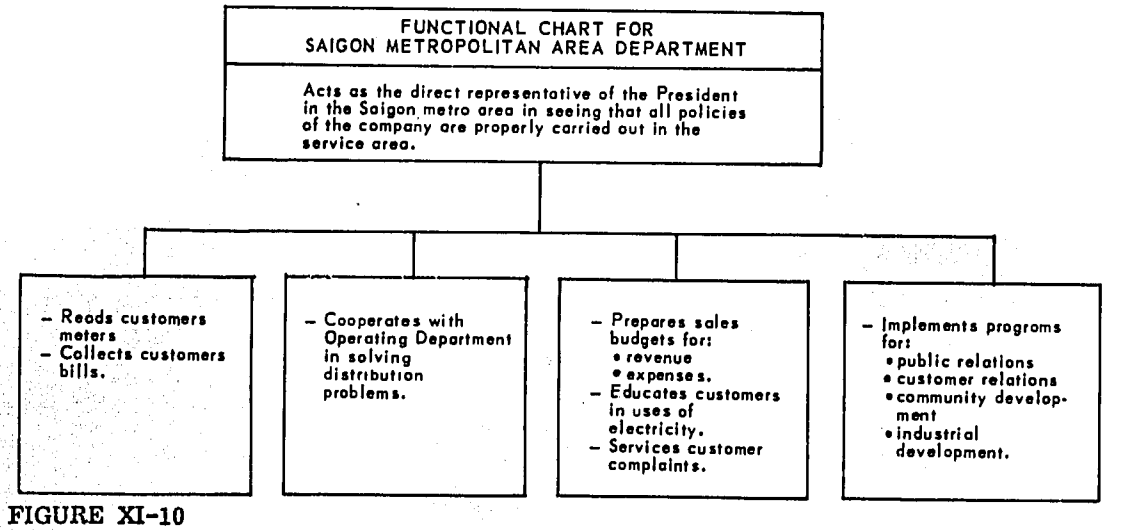

FIGURE XI-10

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Provincial Department

This department (see Figure XI–11), will be one of the important components of VPC. It will be responsible for all operations outside the Saigon metropolitan area with the cooperation and assistance of the various staff departments of VPC. This department will have the responsibility for direct work on community development, industrial development, public relations, and customer relations in the entire nation outside the Saigon metropolitan area.

To be effective, these functions should be carried out by the division managers who will be directly responsible for all functions in their areas through district managers placed in strategic population centers throughout the division. The district managers will be responsible for service to customers and for customer relations in their particular area.

In carrying out plans for industrial development outlined by the Commercial Department, these division and district managers will work with local leaders to obtain local acceptance and support of their plans.

Legal Counsel

The Legal Counsel, assisted by a staff selected by him, will provide legal advice to the President and to others on matters having to do with company activities. (See Figure XI–12.)

Although this function in the company is not at a departmental level, its services and advice should be available to all components of the company. In provincial centers, it is assumed that local legal counsel may be employed either on a direct basis or by retainer. In either event the selection should be made jointly by the Legal Counsel, the Vice President – Provinces and the division manager.

Cooperation between the Legal Counsel and the departments of the company is necessary and obvious.

Auditing Department

The Auditor and his staff (see Figure XI–13), review and report on all departmental operations and procedures to assure management that delegated functions are being performed in accordance with company policy and approved directives. Control procedures in all phases of the business are investigated particularly fiscal collections and expenditures.

It is the responsibility of the Auditing Department to make certain that all money collected is properly accounted for, that all expenditures have the proper authorizations, and that material and services paid for have been received.

Where dishonesty is suspected at any level, it is the responsibility of the Auditor to determine the facts and present them to the President of the company. It then becomes the duty of the President to take appropriate action.

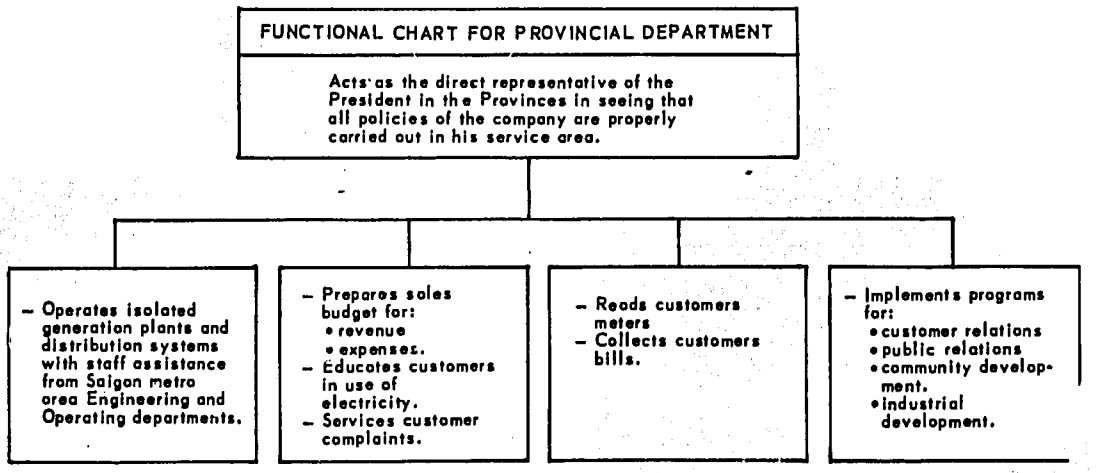

FIGURE XI-11

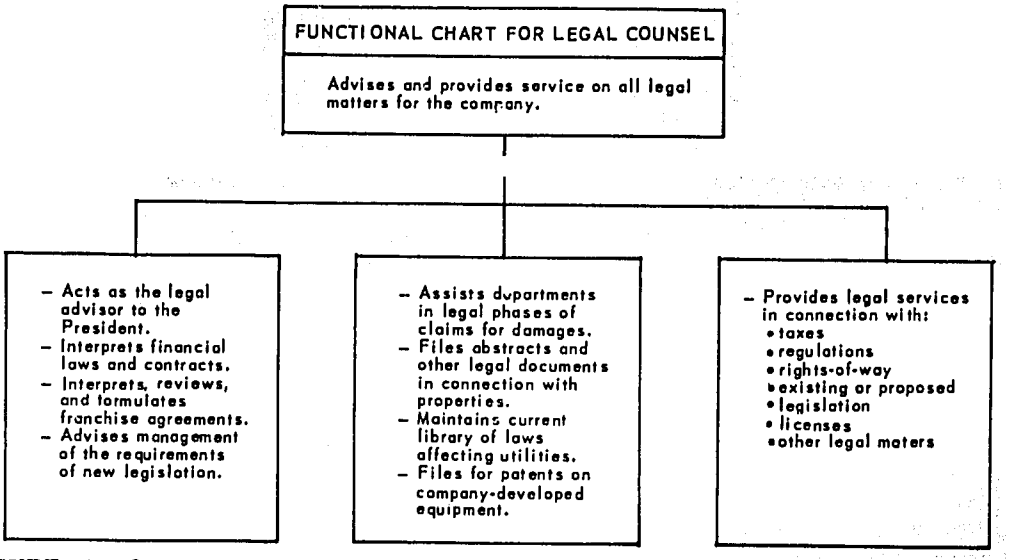

FIGURE XI-12

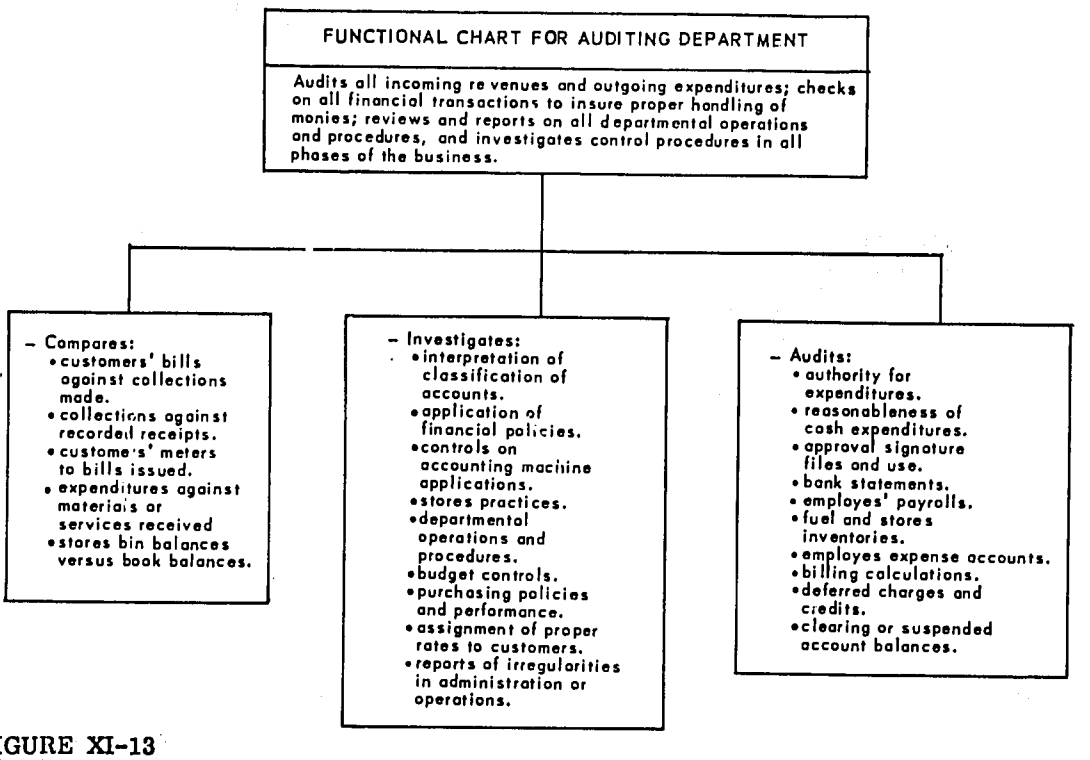

FIGURE XI-13

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Personnel Practices and Training

In its final report dated August 1971, MST reports the results of its work with VPC in personnel matters. The discussion in this report is based, in large measure, on the findings of MST.

The personnel department as recognized in US industry was practically nonexistent as of June, 1968. There were a few people involved in record keeping but there was no manager. There was no operating personnel department to handle such matters as recruitment, wage and salary administration, labor relations, training, safety, and other related matters. This situation continued until early 1969.

Work done prior to this time on salary problems and personnel regulations was by the administrative inspector who was in a staff capacity to the president.

By August 31, 1971 certain objectives had been accomplished as follows:

1. A basic personnel organization had been established and, although good progress has been made, time will be needed to staff the unit with a sufficient number of trained personnel.

2. Employment procedures are considered adequate. Among other things, the personnel requisition procedure requires an internal search for employes to fill vancancies before employment of a new employe. This is important to morale and will also assist in keeping down overexpansion of the number of employes in VPC.

3. Progress is being made in a wage and salary program. A salary study has been completed showing comparisons between private industry salaries and those of VPC. VPC is considering the establishment of a bonus system based on performance indices, such as load factor, fuel consumption, operating efficiency, percent of collections to billings, expenses in relation to kilowatthours generated, etc. VPC is aware that a good wage and salary program is a key factor with respect to morale

4. Personnel records are receiving attention and early in 1971 personal data was gathered for all employes for use in personnel programs.

5. VPC employes are receiving training in the use of the English language under supervision of USAID. Sessions for linemen training are held but there is a lack of equipment, and training manuals need to be developed. Training has been done in turbine and diesel maintenance by sending employes to the US. Personnel have also been sent to the US for utility executive training.

USAID is presently considering the following programs: Training 35 employes in the operation of diesel generator plants, 35 employes in the overhaul of diesel generators, 35 employes in the construction and maintenance of distribution lines, 30 employes in warehousing and logistics, and 25 employes in maintenance and overhaul shop work.

In addition, a number of outstanding students in the above program will be selected for additional training as instructors so that VPC can continue the training program. Training aids and necessary tools and equipment are to be provided.

A computer training program should be established as discussed in Section VIII.

A training program should be established for training of middle management.

Top management should have an opportunity to visit utilities, banks and financial institutions, and regulatory commissions. It should bring specific problems relating to VPC for discussion purposes. When financial negotiations are underway, a visit to the banking institutions should be made even though the bank may send a "team" to VPC. Opportunity should be taken to see how other utilities handle similar problems. Continuing contacts of this kind are valuable in many ways and assist in establishing a good image for the company.

USAID is setting up a program whereby three very high level consultants would work with VPC for 12 to 18 months. One of the consultants would have the experience of a chief executive of a utility company and with as broad a background as possible. The second would be a financial expert with good knowledge of accounting procedures and regulatory matters and who had actually had the responsibility in his company of planning, arranging and negotiating, for both short- and long-term credit and security sales. The third would be a high-grade systems development expert with broad experience in a system or systems having both hydroelectric and thermal electric generating plants.

Programs should be established to further train transmission and distribution personnel. This is discussed in Section VI.

Training programs should be set up in the field of rates and rate analysis.

In summary, a careful and detailed review of existing and proposed training programs in all departments of the company and at all levels should be undertaken. Such a review in conjunction with a detailed review and study of

the personnel needs of VPC for at least five years in the future, will result in an estimate of the number of people in each category and the number needed in the company. A program such as this could assist in assuring only the necessary number of people required to operate and manage the company in an efficient manner.

In regard to the development of a manpower planning and development program, the basis for such a program has been established. A personnel inventory has been made, a forecast procedure established, and a supervisor appointed.

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