The University of Manitoba

WATER POWER PLANNING IN SAO PAULO-BRASIL

A Study of two Sequences of
Power Development using the
Sequential Analysis Methodology

Master's Thesis presented by
Ruth Camargo
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Abstract

The objective of the present study is to show how to analyse sequences of power development from the economic point of view using the Sequential Analysis Methodology.

We will be dealing with "Centrais Eletricas de São Paulo" Generating System. We used real data whenever it was available. Additional information came from several existing reports, including some cost estimates.

To show the methodology we studied two sequences A and B and compared one another. These sequences differ from one another only in the schedule of construction of some power plants. The period of study was of 20 years, from 1971 to 1990. Assumptions were necessary like in other long-term studies. Some simplifications were introduced to permit us to cope with the work in the available time.

Chapter 1

1.1. Introduction

Power utility companies are continously faced with the problem of adding more generating capacity to its system to meet the growing load demand. The alternatives to accomplish this are numerous. First, there are the different energy sources and second there is the date and magnitude in which each one should be developed. Two important aspects in the evaluation of a power system, to be pointed out in this brief introduction, are first, that each new station must not be considered as an isolated one but as a unit integrated, chronologically, in the whole system and second, that the analysis must be extended over a significant period in which several units are introduced forming, with the existing ones, a sequence of power stations. One would like to investigate quite a few possible alternatives and make an economic evaluation of them before deciding which should be the best sequence of development to follow.

The planning of a generating system has to be done a few decades ahead. Commitments are made several years ahead taking into account the time involved the decision to construct a power station up to the time it starts to sell energy.

These power development planning studies usually are made over a period of 20 to 30 years. Like in other long-term studies it is very sensitive to the assumptions that are being made.

Electricity can be generated by different sources and in a power system the main problem is to find the most economical and reliable combination of them to cope with the power demand. These are the hydro power plants, the gas turbines and the steam power plants; the last ones must be fueled with coal, oil, natural gas or with the nuclear fuel. Each one has a different cost structure. A hydro plant, for instance, has a high initial investment, a relatively low fixed annual charge, no variable charge and usually comes in large blocks of capacity. On the other hand steam plants have a low initial investment, a higher fixed annual charge, a significant variable charge (mainly cost of fuel) and may be introduced in small units. Due to this fact, a system is usually composed of both hydro and steam plants, each one operating in a certain level of the load duration diagram.

To be more precise concerning the cost structure mentioned above, the nuclear power plants are in between the hydro and the coal or oil fired plants.

1.2. Objective of Thesis

We want to show in this thesis the importance in power planning of a broad investigation of all possible alternative development plans before taking a decision. The amount of money involved in these power developments are such that it is imperative that an economic analysis is done to show the merits of each plan. Usually this economic analysis is simplified to a cost comparison between the different plans once the benefits are the same that is, are the production of the energy to cope with the demand. Other times, when intangibles are involved, the analysis gets more complicated resulting for different people different value to intangibles and we do not have yet a methodology to analyse intangibles that is accepted by everyone. Always it is very important that planners show to the decision makers everything that is involved on each alternative and how much it costs.

We propose in this paper to show how to make a comparative evaluation in the field of power planning using the Sequential Analysis Methodology. In order to do this we could choose any example and our choice fell on a hypothetical problem that seems to me very interesting.

The power system that we shall be dealing with in this thesis is the "Centrais Elétricas de São Paulo" (CESP) Generating System. "Centrais Elétricas de São Paulo" is the company responsible for the generation of electricity the majority of the São Paulo state market.

The São Paulo State power market is mainly in the São Paulo city and surrounding areas, the whole area called the "Grande São Paulo" (Great São Paulo). In this area is concentrated the largest industrial complex of not only Brasil, but of all South America, and consequently where we have the largest energy consumption in the country.

We shall investigate if the hypothetical postponement of the construction of the Ilha Solteira power plant would have been more economic than the construction now. Of course this is only an academic study for, Ilha Solteira is already under construction, with its first turbines sheduled for 1973.

In a hydro station normally the largest part of the capital cost is invested before the first turbine can be installed; these initial expenditures are related with the construction of the dam and spillway which involves the construction camp, construction equipment, land rights and relocations, civil works, engineering and administration and interest during construction. Only about 20 per cent of the capital cost is associated with the turbines and generators. Ilha Solteira is a power plant with a low cost per KW installed (US$ 196) but very high initial investment (US$ 627 millions). Of this total cost we could assume that the parcel correspondent to the turbines and generators could be distributed through the years as they were installed.

Looking at CESP present system of 2050 MW installed capacity and a demand of 1250 MW we are encouraged to assume in this study that it is too early to add to the system a power plant of Ilha Solteira's magnitude. There are other smaller developments that should have taken place before. With this in mind we found very challenging the investigation of the postponement of Ilha Solteira in comparasion with the actual course of development to find out which one would have been cheaper.

1.3. Methodology of the Investigation - Sequential Analysis

We have mentioned earlier the importance or the study of alternatives sequences of power development and the following economic evaluation of them. The economic evaluation of sequences of power development is not a very simple matter for there are a number of different kinds of variables involved.

The first thing we have to know is that different kinds of stations, hydro,steam conventional and nuclear have a different cost structure. This has already been explained in the beginning of the chapter, when we were trying to show why usually the most economic power system results from a combination of hydro and thermal stations. Each station is more advantageous compared to the others if operated at a certain interval of load factors.

Second, we cannot make a comparison between alternative power stations if we consider the stations isolated from the rest of the system. We have to consider a whole sequence of power developments over 20 to 30 years to be compared to another whole sequence of power developments over the same period. We also carry the analysis during the entire life time of the power plants. Since the thermal plants have a useful life of half the hydro plant, we consider at half way, in the analysis, the substituion of the thermal plant by another exactly the same.

In composing alternative sequences of power development, for a certain system, for the future 20 to 30 years, the first thing we have to prepare is an energy load forecast. There are various methods of arriving at future energy needs and they vary from extrapolations of past energy consumption to detailed analysis of future specific uses. They all take into account up to different degrees the past experience in Brasil and in other countries and the estimates for future economic development of the region. Once we have prepared these curves - energy and peak plus reserve capacity demand (For example see Figure nº 2.5.) - we assume that this is what the system has to supply in the forecoming years. The power industry is not allowed to run short of energy and the demand forecast is what we have to assume it has to produce, even in the most adverse river conditions, in case the system includes hydro stations.

Once we have ready a power load forecast for the system we must prepare a list of all possible future hydro power developments, and the characteristics of each one: site location, stream flow records at the site, available head and cost estimates. Next we must have costs on the other kinds of power stations: steam power plants, and in these we must consider, conventional (coal, oil and natural gas) and nuclear.

Then we start to compose a number of sequences of power development, all of which produce enough to meet the market requirement during the period of study. Once we have accomplished this we proceed with the economic evaluation of each sequence. We assume that the benefit of each sequence is just the production of the energy demand, for surplus capacity and energy are of little value. Since every sequence has the same benefit the economic analysis turns out to be a cost comparison. One of the means of marking this economic analysis of alternative power developments is through the "Sequential Analysis Methodology".

. The annual costs of each sequence are composed of fixed annual charges and variable annual charges the calculation of annual fixed charges offer no difficulty. They consist of: interest, depreciation, operation and maintenance. The cost of energy from hydro plants is composed of only annual fixed charges, but the cost of energy from thermal plants is composed of fixed charges plus variable charges which consist of incremental operation and maintenance plus the cost of fuel. To calculate the cost of fuel, we must determinate each year the average thermal energy requirements and this is the most time consuming part of the sequential analysis study. This calculation if done accurately involves a large amount of work hours and computer services. When time and money are not available, one has to devise an approximate way of calculating these average thermal energy requirements and we shall explain, in the next chapter, how we overcome this difficulty in our study.

After the determination of the total annual cost for each sequence and for each load condition, we proceed with the calculation of the present values of these costs and total up these figures finding out for each sequence a total present value of all costs. Now we can compare the total costs of each sequence at a common data and determine the least costly alternative or, in other words, the most economical one.

We have described briefly how to proceed to evaluate the merits of sequences of power development utilizing the sequential analysis methodology. In the next chapter we shall explain in more detail how this is done.

Chapter 2

2.1. The Organization of the Brazilian Power Industry

Brasil, for the purpose of power planning is sub-divided in five areas: north, north-east, west-central, south-central and south. (See Figure nº 2.1.)

The South Central Region embraces the states of São Paulo, Minas Gerais, Guanabara, Rio de Janeiro and Espirito Santo. It occupies a very important place in the country holding 45% of its population and is responsible for 70% of the country's industrial production, 40% of its agricultural production and 80% of its electrical power consumption.

Concerning the organization of the Brazilian power industry we must mention first the name of ELETROBRÁS, abbreviation to "Centrais Eletricas Brasileiras" (Brazilian Central Electric), its function and responsibility in the power planning of the country. ELETROBRÁS is a joint stock company created in 1962 by the federal government and in which it holds the majority of the shares. It operates by means of its associated and subsidiary companies and has the task to execute the national energy policy. Subsidiary are the companies in which ELETROBRÁS has the majority of the shares and associates are those in which it has minority of the shares.

This federal agency has three main functions: first, it is a planning agency, and as such responsible for the formulation of the national energy policy; second, it is a holding company having shares of almost all power utility companies that operate in Brasil; third, and very important, is the function of investment bank in the sector, helping finance most of the power plants including transmission and distribution lines under construction.

The policy of the Brazilian government for the expansion of

GEOGRAPHIC REGIONS OF BRASIL

FOR POWER PLANNING

FIGURE nr 2.1.

our power system is that it should be done essentially through federal and state owned utility companies.

As subsidiary and associates of ELETROBRÁS we have a number of power utility companies that operate in the South Central Region. The largest ones are: CESP, FURNAS, C.P.F.L. and CEMIG. We also have a private company called "Rio Light and São Paulo Light - Serviços de Eletricidade S.A.". São Paulo Light is the company formerly responsible for all power generation and distribution in the area of São Paulo and present only expanding its distribution system.

FURNAS, abbreviation to "Centrais Eletricas de Furnas", a subsidiary of ELETROBRÁS is mainly a supplier of electricity in bulk for the South Central Region market.

CEMIG stands for "Centrais Eletricas de Minas Gerais" and is an associate of ELETROBRÁS. It serves the major part of Minas Gerais and also sells bulk power to other concessionaires.

C.P.F.L. abbreviation for Companhia Paulista de Força e Luz is a subsidiary of ELETROBRÁS responsible for the distribution of electricity in part of the São Paulo State. Its generating capacity is small and it buys energy from FURNAS and CESP.

CESP, as we have mentioned earlier is an associate of ELETROBRÁS, responsible in the future for most of the electricity production and part of the distribution in the São Paulo State. CESP originated in 1966 from the merging of eleven smaller companies and is one of the largest companies in Brasil. Its capital is distributed among the São Paulo government with 89% of the shares, the federal government with 10% and the remaining 1% belonging to private shareholders, and other state governments.

Figure nº2.2. shows the area in the São Paulo State in which CESP is responsible for the distribution of electricity. Table nº 2.1. shows the distribution among the several companies in 1970 and projected for 1980 of the supply of power in the South Central Region.

PARTICIPATION OF CESP IN THE DISTRIBUTION OF ENERGY IN THE SÃO PAULO STATE

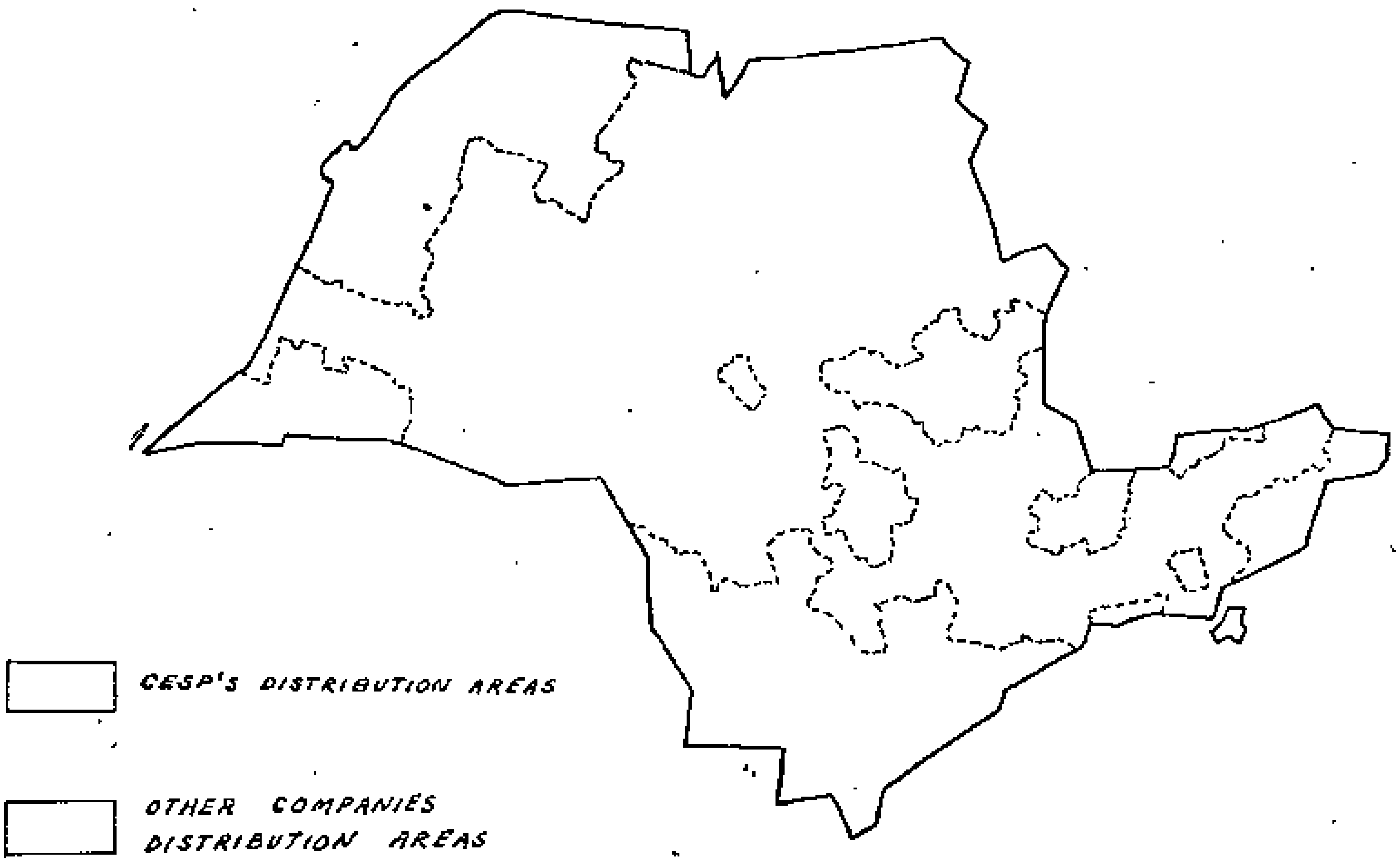


FIGURE nº 2.2.

R.C.

PARTICIPATION OF CESP IN THE DISTRIBUTION OF ENERGY IN THE SÃO PAULO STATE

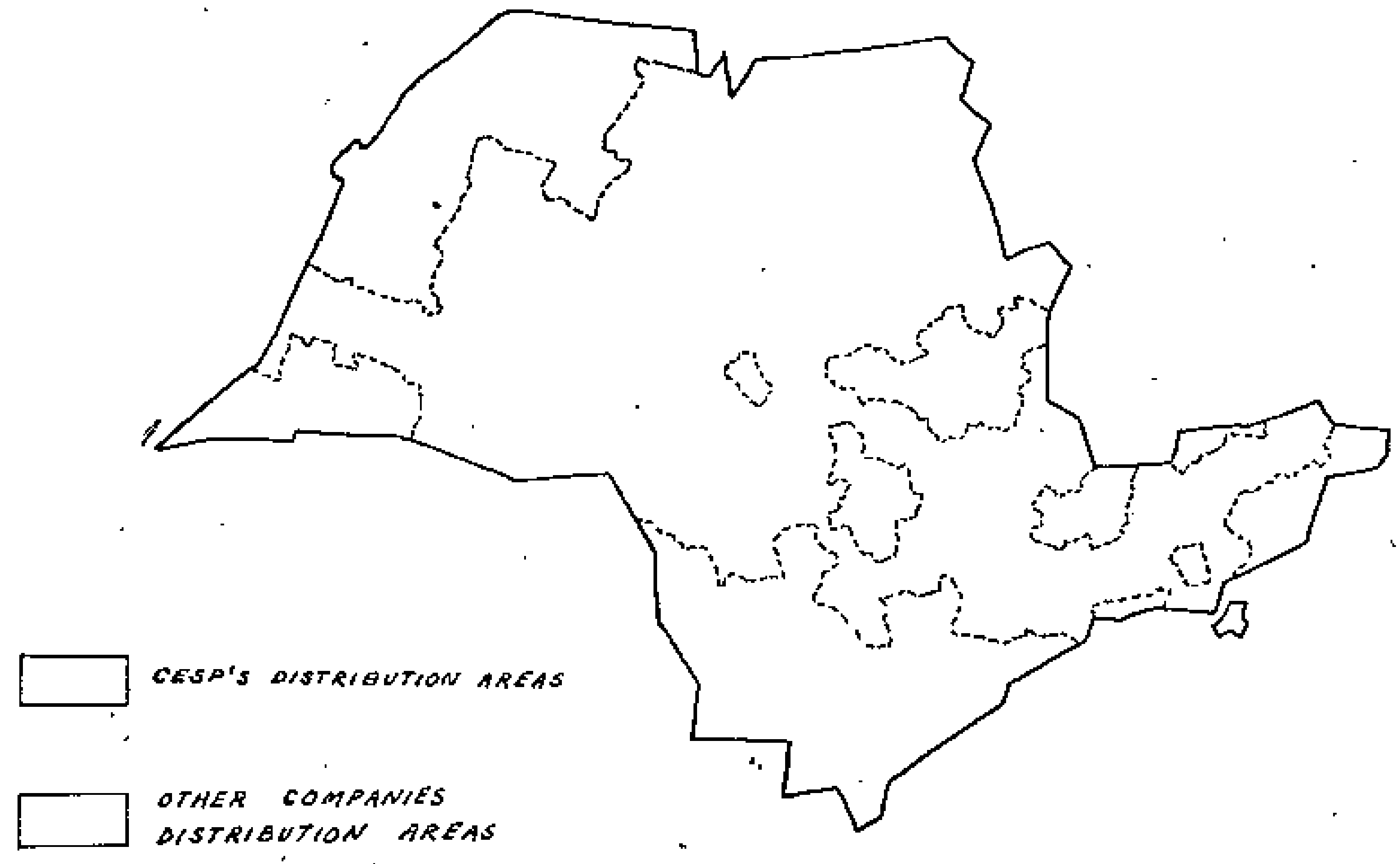


FIGURE nº 2.2.

R.C.

Table nº 2.1. CESP's Position in the Power Supply of the South Central Region

	Per cent of total energy production of the South Central Region	
	1970	1980
CESP	16	34
FURNAS	24	33
LIGHT	26	11
C.P.F.L.	8	3
CEMIG	10	14
Others	16	5

Source: "Relatório Técnico 1970 - CESP"

2.2. CESP's present system composition

2.2.1. Geography

The State of São Paulo embraces part of the Paraná basin and part of smaller Coastal basins, as the Paraiba basin and Ribeira basin. (See Figure nº 2.3.).

Near the coast, we encounter a mountain range, called "Serra do Mar", extending from north to south of the State on Brazilian Atlantic coast. So, from sea level, on the direction of the interior of the continent we have a small coastal plain and a mountain range, which brings us up to elevations around 700 m followed by a plateau where is situated the city of São Paulo. From here the slop drops gently toward the interior of the continent until the Paraná river.

As a result from this geographic configuration we have some high head power developments near the coast, usually with the reversion of the upper part of a river basin to the sea, and cascade developments in the rivers running to the interior, most of them affluents of the Paraná river. The Paraiba and Ribeira rivers, with headwaters in the "Serra do Mar" run for a while paralled to the coast and then, toward the sea, each one with its own basin.

2.2.2. History

In the past, some 30 years ago, engineers working for a private enterprise, now called São Paulo Light - Serviços de Eletricidade S.A., envisioned the most interesting power development with the reversal of the waters of the Upper Tietê and Pinheiros rivers to the sea. In this plan with only a few meters of pumping they could use a head in the order of 700 meters in their turbines. This development supplied São Paulo with abundant electricity which must have been one of the incentives to the tremendous industrial development that we find now in the area. This came in addition to the already existing favourable situation of São Paulo, having an excellent moderate climate and easy maritime communication via the port of Santos, only 60 Km from São Paulo.

Following the natural procedure, once the hydraulic potential near the load center was exhausted, one had to look for sites more distant. This is when the development of Rio Pardo, Rio Tietê and Rio Paranapanema begins and today the development of Rio Paraná, with the Jupiá and Ilha Solteira power plants, the last one, still under construction.

2.2.3. Existing system

CESP has the following power stations in operation or under construction. (See Figure nº 2.4.)

Table nº 2.2. CESP's Power Stations (Jan. 1971)

Name Hydro Stations:	Installed Capacity (MW)	Head (m)	Condition (*)
Tietê:			
Barra Bonita	122	20	0
Bariri	124	23	0
Ibitinga	114	23	0
Promissão	210	24	C
Pardo:			
Graminha	68	94	0
Euclides da Cunha	94	90	0
Limoeiro	25	27	0
Paranapanema:			
Jurumirim	85	31	0
Xavantes	400	69	0
Salto Grande	61	18	0
Capivara	640	47	C
Paraná			
Jupiá (**)	900	23	0
Ilha Solteira (**)	2560	45	C
Others:			
Jaguari	20		0
Thermal	40		0

(*) Condition: 0 - in operation; C - under construction

(**) Final installed capacity at Jupiá: 1400 MW

Ilha Solteira : 3200 MW

CESP's present (January 1971) installed capacity with the recent addition of Xavantes power plant to its system is:

Table nº 2.3. - CESP's Present Installed Capacity

Power Plants		Installed Capacity (MW)
Tietê:	Barra Bonita	122
	Bariri	124
	Ibitinga	114
Pardo:	Graminha	68
	Euclides da Cunha	94
	Limoeiro	25
Paranapanema:	Jurumirim	85
	Xavantes	400
	Salto Grande	61
Paraná:	Jupiá	900
Jaguari:	Jaguari	20
Thermal:		40
T O T A L		2043

Table nº 2.4. - CESP's Reservoirs

River	Name	Usable Storage Capacity in million m^3	Usable Storage Capacity (m^3/s.month)	Condition (*)
Tietê:	Barra Bonita	1550	600	O
	Promissão	2100	811	C
Pardo:	Graminha	630	193	O
Paranapanema:	Jurumirim	2900	1120	O
	Xavantes	3000	1160	O
	Capivara	1500	580	C
Paraná:	Jupiá	750	290	O
	Ilha Solteira	10000	3860	C

(*) Condition: O - in operation; C - under construction

2.3. Possible Capacity Additions

As we have just seen CESP's system is in the all-hydro phase of development. We say that a system is in the all-hydro phase of development when it has a majority of hydro stations in its system. In the South Central Region there are still some potential hydro developments of which CESP has a chance to get its concession. After these have been exhausted the load growth will be met by steam stations, conventional and nuclear, and maybe a little incremental capacity at some hydro power stations. The system passes then from the all-hydro phase to the hydro-steam phase.

The natural resources in Brasil are under control of the federal government, and for the construction of a power station it is necessary to obtain a permit from the government which for hydro plants normally are valid for 30 years.

2.3.1. Potential Hydro Developments

According to CANAMBRA inventory and preliminary studies (R-5) we have in Table nº 2.5. the following most interesting potential hydro developments.

Table nº 2.5. - Potential Hydro Developments

Name	Installed Capacity (MW)	Head (m)	Usable Storage Capacity (million m^3)	Usable Storage Capacity (m^3/s.month)
Paranapanema river:				
- Piraju	120	56	pondage	pondage
- Canoas	260	33	550	212
- Taquaruçu	330	26	pondage	pondage
Grande river:				
- Água Vermelha	1380	55	pondage	pondage
Paraná river				
- Ilha Grande	3840	37	20000	7720

With the total installed capacity of 2050 MW in 1971, CESP has only a capacity demand plus reserve of 1250 MW. (See Figure nº 2.6.)

A few years ago CESP doubled its installed capacity with the introduction of Jupiá (900 MW) and will soon introduce another very large power plant in the Paraná river, Ilha Solteira (2560 MW) which will double again its installed capacity. Ilha Solteira's first turbines are scheduled to come into operation in the year 1973.

CESP has also finished a feasibility study for the installation of there 200 MW units of oil fired thermal stations to complement its hydro energy generation. The project has not been approved for immediate construction mainly because of shortage of fuel oil from the Brazilian oil refineries. Most likely although, near 1980, the 600 MW thermal power plant shall be built.

2.4. CESP's Power Market

To reach at a power market forecast for CESP's system, one must first prepare a power market forecast for the whole South Central Region. ELETROBRÁS has recently (June, 1969) finished a study on power forecast through 1985 for the South Central Region called "Power Market Study and Forecast for the South Central Region". CANAMBRA formerly had also prepared a study on power market forecast for the South Central Region. ELETROBRÁS study is, in every sense, a new one and did not attempt to use CANAMBRA estimates. This was not to criticise CANAMBRA results but to give a fresh sense of objectivity to the matter. The basic assumption used for the preparation of this study was that the country's economy and its evolution is one of the major determinants of electric power consumption level and growth rate.

Based on ELETROBRÁS, power market study the Planning Department of CESP supplied us (R-P) with the following projection for the period from 1971 to 1990 for CESP system.

Table 2.6. - CESP's Load Forecast (High Rate)

Year (1)	Energy demand (MW continuous) São Paulo and South Mato Grosso Market (2)	Energy demand supplied by others (MW continuous) (3)	Energy demand supplied by CESP (MW continuous) (4)	Capacity demand (MW) (5)	Capacity plus reserve (MW) (6)
1970	2382	1762	620	914	1016
1971	2625	1774	851	1255	1394
1972	2893	1798	1095	1615	1794
1973	3188	1822	1366	2015	2239
1974	3514	1852	1662	2451	2723
1975	3828	1882	1946	3139	3488
1976	4185	1918	2267	3656	4062
1977	4575	1954	2621	4227	4697
1978	5002	1996	3006	4848	5387
1979	5470	2038	3432	5535	6150
1980	5910	2080	3830	6503	7226
1981	6506	2080	4426	7514	8349
1982	7155	2080	5075	8616	9573
1983	7874	2080	5794	8937	10930
1984	8664	2080	6584	11178	12420
1985	9471	2080	7391	12548	13942
1986	10422	2080	8342	14163	15737
1987	11470	2080	9390	15942	17713
1988	12623	2080	10543	17900	19889
1989	13893	2080	11813	20056	22284
1990	15291	2080	13211	22430	24922

Table nº 2.6. - CESP's Load Forecast (Median Rate)

Year (1)	Energy demand (MW continuous) São Paulo and South Mato Grosso Market (2)	Energy demand supplied by others (MW continuous) (3)	Energy demand supplied by CESP (MW continuous) (4)	Capacity demand (MW) (5)	Capacity plus reserve (MW) (6)
1970	2355	1762	593	875	972
1971	2582	1774	808	1192	1324
1972	2830	1798	1032	1522	1691
1973	3102	1822	1280	1888	2098
1974	3402	1852	1550	2286	2540
1975	3683	1882	1801	2905	3228
1976	4007	1918	2089	3369	3743
1977	4360	1954	2406	3881	4312
1978	4744	1996	2748	4432	4924
1979	5162	2038	3124	5039	5599
1980	5549	2080	3469	5890	6544
1981	6070	2080	3990	6774	7527
1982	6639	2080	4559	7740	8600
1983	7262	2080	5182	8798	9776
1984	7945	2080	5865	9958	11064
1985	8631	2080	6551	11122	12358
1986	9444	2080	7364	12503	13892
1987	10334	2080	8254	14014	15571
1988	11308	2080	9228	15667	17408
1989	12375	2080	10295	17479	19421
1990	13545	2080	11465	19465	21628

Table nº 2.6. - CESP's Load Forecast (Low Rate)

Year (1)	Energy demand (MW continuous) São Paulo and South Mato Grosso Market (2)	Energy demand supplied by others (MW continuous) (3)	Energy demand supplied by CESP (MW continuous) (4)	Capacity demand (MW) (5)	Capacity plus reserve (MW) (6)
1970	2329	1762	567	836	929
71	2539	1774	765	1128	1253
72	2768	1822	970	1431	1590
73	3017	1852	1195	1763	1959
74	3289	1918	1437	2119	2354
75	3538	1954	1656	2671	2968
76	3829	1996	1911	3082	3424
77	4144	2038	2190	3532	3924
78	4486	2080	2490	4016	4462
79	4855	2080	2819	4544	5049
80	5188	2080	3108	5277	5863
81	5635	2080	3555	6036	6707
82	6122	2080	4042	6862	7624
83	6651	2080	4571	7761	8623
84	7225	2080	5145	8735	9706
85	7792	2080	5712	9698	10776
86	8465	2080	6385	10840	12044
87	9197	2080	7117	12083	13426
88	9993	2080	7913	13435	14928
89	10858	2080	8778	14903	16559
90	11798	2080	9718	16499	18332

Growth rate (R-P)

		Annual % of load growth			
		70/75	75/80	80/85	85/90
SÃO PAULO	High rate	10.2	9.3	10.0	10.0
	Low rate	9.0	8.2	8.6	8.6
MATO GROSSO	High rate	15.4	20.8	18.0	18.0
	Low rate	14.9	19.1	16.0	16.0

CESP'S LOAD FORECAST LOW RATE

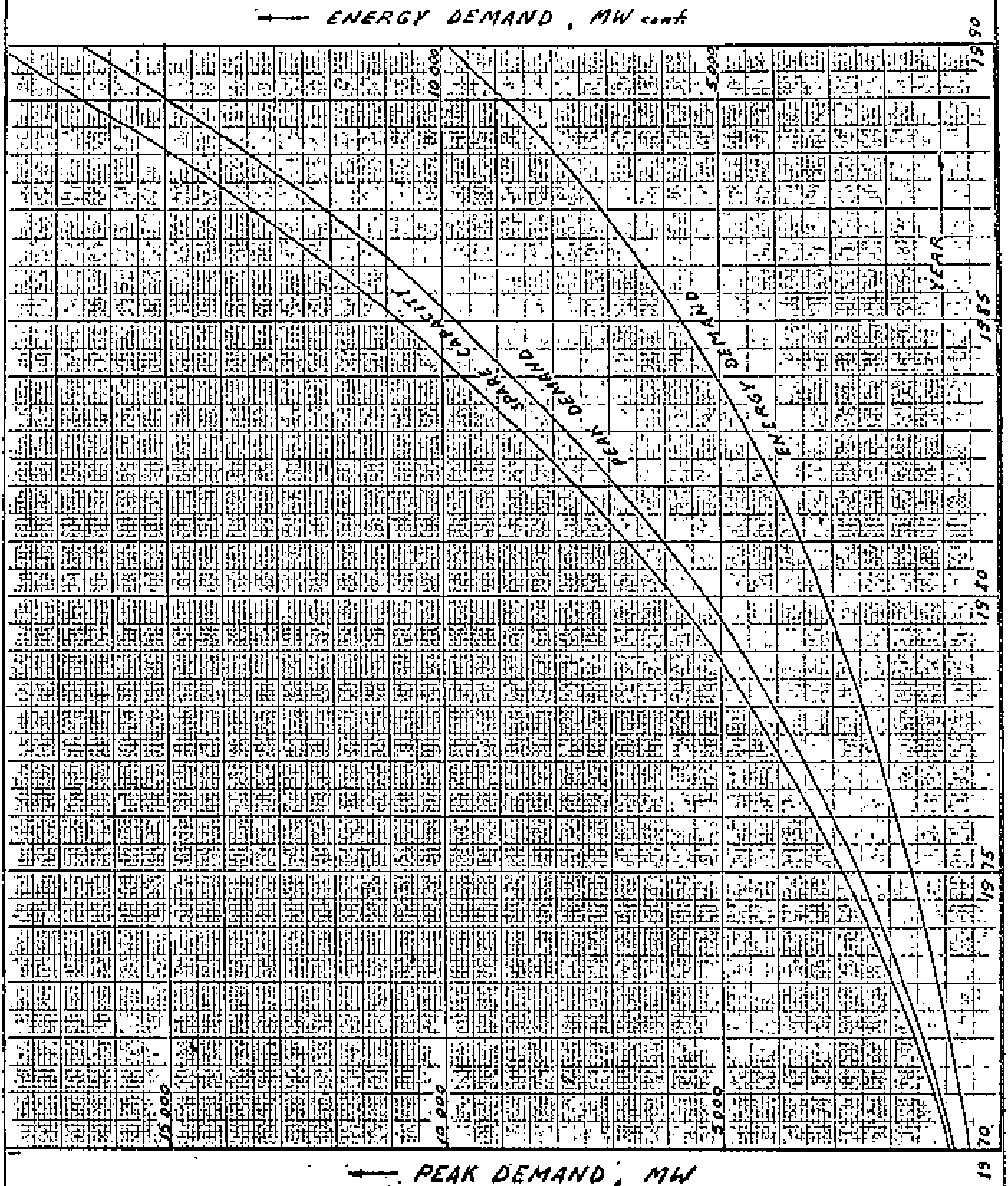


FIGURE nº 2.5.

Chapter 3

Study Presentation

We have in the preceeding chapters tried to give the reader a brief introduction to power planning problems and some information about the Brasilian power industry organization and particularly about CESP's power system. We have expressed the importance of the planning studies to the power industry and how challenging the problem of finding the most attractive sequence of power developments become. We have said before that one can evaluate the merits of each sequence of development through the sequential analysis methodology. We shall explain in this chapter how we went about in our work of the evaluation of two sequences: Sequence A in comparasion to Sequence B.

We have showed CESP's existing system, CESP's load forecast and have listed the potential hydro power developments for the expansion of its generating system in the future. Now we shall present and explain all the steps and necessary calculations to accomplish this economic analysis. We must start first by the presentation of the cost estimates on potential power developments, both hydro and thermal.

We shall remind the reader that through our study we have introduced some simplifications so that we could cope with the work in the available time.

3.1. Cost Estimates

3.3.1. Hydro Power

The costs of hydro power plants varies tremendously depending on the available head, streamflow records, site topography and distance from the load center. Nowadays we usually are faced with potential hydro developments distant from the load center for the near ones have already been developed or incremental capacity at existing sites.

The following cost estimates of the hydro power plants under construction were obtained in CESP's Planning Department (R-P). The costs of potential power plants were taken from CANAMBRA Feasibility Reports (R-5) and atualized to 1970 costs, in the same proportion that CANAMBRA figures (1965) were different from CESP's actual costs of power plants already constructed or under construction. This is only an approximation and in a real study it would be necessary to review all CANAMBRA Feasibility Reports in detail and make new cost estimates.

Table nº 3.1. - Hydro Plants Cost Estimates

Name	Capital Cost in millions of US$			Installed Capacity (MW)	Cost US$/KW (*)	Trans-mission Costs US$/KW (**)
	Canambra's estimate 1965	CESP's estimate 1970	Estimate in our study 1970			
Ilha Solteira	430	627	627	3200	196	67
Ilha Grande	487		660	3840	172	70
Capivara	112.4	155	155	640	242	60
Piraju	29		39	120	325	20
Canoas	51.5		69	260	265	24
Taquaruçu	52.8		70	330	212	60
Promissão		130	130	210	620	12
Água Vermelha	191.9		244	1380	177	70

(*) These costs do not include transmission costs.

(**) Transmission costs taken from Canambra Report

Fixed Annual Charge: Interest 8%

(Sinking Fund) Amortization (50 years life) 0.2%

Operation and Maintenance 0.8%

Total .... 9 %

3.1.2. Thermal Power

- Conventional Oil Fired Steam Plant

CESP recently ordered a study on thermal complementation of its hydro system. This study was done by a consortium of two firms - Sanderson and Porter, Inc., New York and Serviços Eletrotécnicos Ltda. (Seltec) (R-7) and was finished in February 1970. The study came to the conclusion that CESP needed three 200 MW units of conventional thermal power to be added to the system as soon as possible and prior to the commissioning of Ilha Solteira plant. The project cost estimate was prepared on the basis of scheduled operation for Unit nº 1 on November, 1973, Unit nº 2 on February, 1974, and Unit nº 3 on April, 1974.

Thermal Plant	Total Inst. Capacity (MW)	Capital Cost (millions of US$)	Cost in US$/KW	Fuel Cost
3, 200 MW units of oil fired thermal plant	600	129	215	4.0 mills/kwh (47 cents/10^6 BTU)

Note: These costs include transmission.

Fixed Annual Charge: Interest 8%

(Sinking Fund) Amortization (25 years life) 1.4%

Operation + Maintenance 1.6%

Total ....11 %

- Nuclear Power

The first nuclear power station in Brasil is now starting construction by FURNAS company. It shall be a 600 MW unit and will be situated in the Atlantic coast in the state of Rio de Janeiro near the city of Angra dos Reis. Bids are already open to the world market but Brasil's choice and prices are not yet available to the public.

A recent study made for the U.S.Atomic Energy Commission (R-9) shows that, presently, the unit capital cost of a nuclear plant (Light Water Reactor) is 25% higher than the cost of a fossil fuel plant. The same study also came to up to date costs for units of 1000 MW each, in the United States, one nuclear and another fossil. These costs were US$ 196/KW for the fossil plants and US$ 240/KW for the nuclear plant. On the other hand we have the costs for fossil plants in Brasil from the recent study done by Sanderson and Porter and Seltec for CESP. This study indicates a cost of US$ 215/KW. From this cost and 25% higher we obtain for nuclear plants a cost of US$ 270/Kw. These costs of US$ 215/KW and US$ 270/KW are consistent with the ones given in the U.S.Atomic Energy Commission Report.

	Installed Capacity (MW)	Capital Cost (US$/KW)	Fuel Cost mills/KWh (R1)
Nuclear Units	1000	270	1.5

Fixed Annual Charge: Interest .... 8.0 %

(Sinking Fund) Amortization (25 years life) .... 1.4 %

Operation + Maintenance .... 2.0 %

Total ....11.4 %

The unit cost for the first Brazilian nuclear plant should be higher than the cost we are assuming here. The reasons are the Brazilian inexperience with the new technology and the lack of industrial background in the nuclear field, shipping costs, etc.

3.2. Sequence Composition

The proposed two sequences of power development differ from one another only in the schedule of the construction of some power plants. A period of 20 years was studied, and at the and of this period both sequences were assumed to have the same composition. This fact allowed us to study only the costs associated within this period, for the rest is a constant to both.

Sequence A is the sequence that represents what CESP has planned up to 1980 and from there on, up to 1990, a hypothetical sequence that was assumed by us.

Sequence B is a hypothetical sequence all the way, in which we postpone the introduction of Ilha Solteira power plant by five years.

To compose these sequences we have worked with CESP's load forecast (See Figure nº 2.5. Table nºs 2.6. and 3.5.) for the 20 year period of study. In Table nº 2.6. we find Col. (4) with the energy demand in MW continuous and Col. (6) the capacity plus resdrve demand in MW of CESP's system. Table nº 3.5. was calculated from the following information in Table nº 3.4. and gives us the required energy, in MW continuous for each month and load year of study.

Table nº 3.4. - <u>Seasonal Load Factor Variation</u>

Month	Per cent of energy to average month	Per cent of annual peak
Jan.	90.7	85.9
Feb.	93.9	88.9
March	95.4	90.3
April	95.9	09.8
May	99.7	94.4
June	100.8	95.4
July	103.3	97.8
August	105.6	100.0
Sept.	104.9	99.3
Oct.	104.2	98.7
Nov.	102.7	97.2
Dec.	101.7	96.3

Source: CANAMBRA.Report Vol. VII, appendix 15

We needed also the flow records at each station, and we obtained from CESP the flows in the period from 1932 to 1959.

The most important thing in composing a sequence is to make sure that it produces enough energy even in the most adverse river conditions. The power industry is not allowed to run short of energy. We call this operation, to verify if the system is <u>firm</u>. We utilize the driest period of record, in our study this was from July 1954 to November 1955, and calculate month per month the available energy in all hydro plants from natural flows plus storage reservoirs and from all thermal plants and compare it with the demand. If we can produce enough energy to cope with the demand in this most unfavourable period of river flows, we say that the system is <u>firm</u> . This, in other words, means to say that we can fully utilize all our hydro capacity.

This operation is done for every load year in the period of study, and that in our study was from 1971 to 1990. For this operation we utilize Table nº 3.7. in Sequence A and Table nº 3.8. in Sequence B. In these Tables we listed for every load year the required energy, next we listed the available hydro energy from natural flows, then the available energy from the thermal plants and then calculated each year the defficiency that had to come from the reservoirs. In the next column we calculated the accumulated defficiency and the largest accumulated defficiency had to be smaller than the total energy available in the storage reservoirs at the time. The available natural energy at each load year depends naturally on which hydro power plants and their installed capacity that we have in operation at that data. In the calculation of the available natural hydro we utilized Table nº 3.6. Next, we checked for every load year if we had the required amount of energy (largest accumulated defficiency) in the storage reservoirs. We have listed in Table nºs 2.4. and 2.5. the existing and potential storage capacity in cubic meters per second during one month to facilitate these calculations. The energy value, in MW months, of each storage reservoir is obtained by the multiplication of the volume in cubic meters per second during one month times the sum of all the heads in meters times efficiency of all downstream hydro plants. We can observe that the energy value of a storage reservoir increases at the addition to the system of a downstream hydro plant.

In Table nº 3.9. we make a summary of the hydro plants characteristics with the calculation of the coefficient (Head.Efficiency).

Table nº 3.9. - Hydro Plants Characteristics

Name	Installed Capacity (MW)	Usable Storage Capacity (m^3/s.month)	Head (m)	Coefficient (Head.efficiency) (: 9.8 : 10^{-3}) ($MW/m^3/s$)
Jurumirim	85	1120	31	.258
Piraju	120	-	56	.460
Xavantes	400	1160	69	.555
Salto Grande	61	-	18	.146
Canoas	260	212	33	.278
Capivara	640	580	47	.387
Taquaruçu	330	-	26	.212
Barra Bonita	122	600	20	.165
Bariri	124	-	23	.191
Ibitinga	114	-	23	.191
Promissão	210	811	24	.200
Graminha	68	193	94	.750
Euclides da Cunha e Limoeiro	119	-	117	1.000
Água Vermelha	1380	-	55	.455
Ilha Solteira	3200	3860	45	.366
Jupiá	1400	290	23	.195
Ilha Grande	3840	7720	37	.291

The simplifications we did here and that we call bulk analysis was to overcome the time consuming work of having to regulate the reservoirs, for each load year, in the dry period and average year conditions. What we did was to look upon the natural energy separately of the energy from storage reservoirs.

We should remind here that our aim is to compose a sequence that produces enough energy to meet the market requirements but not one that produces much more than the requirements. We want to be <u>just firm</u>. It is easy to compose a sequence that produces enough energy when we are not worried with its cost, but, costs are exactly in what we are interested, for we are looking for the least costly alternative for the production of energy demand. To compose a sequence that has much more energy available means that we have surplus energy and that we are over committing investments.

In our study we dedicated ourselves to the evaluation of two sequences and to compare one another. We have assumed that CESP's system is small to incorporate in 1973 a power plant of Ilha Solteira's magnitude, with such a large capacity ready available and high initial investment and assumed we could have done better developing first the small power plants in the Paranapanema river.

Observe that for the calculation of the energy production at each hydro station we did not consider the fact that the available head varies with the water level in the storage reservoirs. This assumption of having a constant available head may or not be very far from reality, depending on each site. It was made here only with the purpose of simplifying the calculations which otherwise would have taken much more time.

Note that we didn't consider transmission losses and this was because we wanted to simplify the problem.

3.3. Cost Computation

Once having determined sequences that produce just enough energy to meet the market requirements in the driest period of record, we know that we have not over committed investments not we should experience any lack of energy. Now we can proceed with the next phase which is the calculation of the costs associated with each sequence. We must have the costs of all sequences to determine which is the least costly and most attractive one. In our case we have two sequences A and B, which after 1990 have the same composition, and this allows us to compute only the costs until 1990, for the remaining period would come in as a constant to both sequences. The fixed annual costs of the existing system means also a constant to both sequences and in a comparative analysis can be ignored.

As we said earlier the most time consuming part is the determination of the average thermal energy requirements for each load year, that expressed in dollars, enter our cost computation as the cost of fuel. Note that we said average thermal energy requirements and that is easy to understand for the thermal energy requirements vary depending on the hydrologic year, and to be unbiased we are looking for an average figure. We realize that in a dry year, when our thermal plants are placed in the base our thermal energy requirements are much larger as compared to a wet year when the opposite occurs.

It is clear then that we are interested in the average thermal energy requirements. To find this accurately one should route for every load year the whole 30 years of record through our hydro plants, see how much energy they could produce being the remaining supplied by our thermal plants. For each load year, we would have then, 30 figures of thermal energy requirements. Next, we would calculate the average of all these figures determining the average thermal energy requirements for each load year. This operation would be repeated as many times as the years we have in the period of study, in the present study 20 years.

In our study we did the following simplification. First, we proceeded in the same way as we did for the verification on the firmness of our system in the dry period, but now with the river flows of the average year we obtained the thermal energy requirements in the average year. The average year is the year that has the same average of the entire period of record. Second, we know that the average thermal energy requirements are not the requirements in the average year, but a reasonable approximation would be that they are equal to: 80 per cent of the thermal energy requirements in the average year plus 20 per cent of the thermal energy requirements in the dry year.

The calculations of the thermal energy requirements in the average year were done in Table nºs 3.11. and 3.12. and for these we utilized the calculations of the natural energy in the average year found in Table nº 3.10.

The computations of the average thermal energy requirements, as above described, was done in Table nº 3.13 for Sequence A and Table nº 3.14. for Sequence B.

Next follows the calculations of the variable charges for each sequence that in other words is to express the average thermal energy requirements in dollars. This was done in Table nº 3.15. for Sequence A and Table nº 3.16. for Sequence B.

Let's recall that we calculated the average thermal energy requirements from our oil fired plants separately from those of our nuclear plants for their fuel cost are different. These thermal energy requirements are listed in Cols.(2) and (3) of Table nºs 3.15. and 3.16.

Let's now calculate the cost of fuel in dollars of producing 1 MW month of energy in each kind of thermal plant.

Cost of oil fuel for 1 MW month:

Cost of oil fuel = 0.004 $ per KWh

C = cost of fuel for the production 1 MW month = $2925

Col. (4) in Table nºs 3.15 and 3.16 is obtained from the multiplication of the coefficient C by Col. (2).

Cost of nuclear fuel for 1 MW month:

Cost of nuclear fuel = 0.0015 $ per KWh

K = cost of fuel for the production 1 MW month = $ 1100

Col. (5) in Table nº $\{{3.15 \atop 3.16}\}$ was obtained from the multiplication of the coefficient K by Col. (3).

Finally Col. (6) is obatined from the addition of Col. (4) and Col. (5) and represents the variable annual charges. This finishes Tables nºs 3.15 and 3.16 and the calculation of the variable annual charges or cost of fuel. We have copied these figures correspondent to the cost of fuel in Col. (8) of Table nº 3.20 for Sequence A and Col. (8) of Table nº 3.22 for Sequence B.

Once we have calculated the variable annual charges we pass to the calculation of the fixed annual charges. Of course the order in which the calculation of variable and fixed charges is done makes no difference but since the calculation of the variable charges takes much more time we wanted to get that done first, but you could prefer exactly the other way around!

We have calculated the annual charges of the hydro additions in Table nº 3.18. for Sequence A and Table nº 3.19. for Sequence B and have utilized the data of Table nº 3.17.

We entered these figures in Col. (5) of Table nº 3.20. for Sequence A and of Table nº 3.22. for Sequence B.

From the costs given in the beginning of this chapter for oil fired plants and nuclear plants we calculated the following fixed annual charges:

Oil fired thermal plant

Annual charge = 11 per cent of capital cost

Units Size in MW	Capital Cost (millions of US$)	Annual Cost (millions of US$)
200	43	4.7
600	129	14.2
1000	215	23.6

Nuclear thermal plants

Annual charge = 11.4 per cent of capital cost

Units Size in MW	Capital Cost (millions of US$)	Annual Cost (millions of US$)
1000	270	30.8

We entered these figures in Cols. (6) and (7) of Table nº 3.20 for Sequence A and Table nº 3.22. for Sequence B.

We next, calculate Col. (9) in the same Tables, which lists the total annual cost in each year of the period of study, and that is from 1971 to 1990.

Once we had calculated the total annual costs for each sequence, we passed to the calculation of the present value (1971) of these costs and next the total present value of all costs, which is the sum of all figures in Col. (11) of Table nº 3.21 for Sequence A and Table nº 3.23. for Sequence B and is given at the bottom of Col. (11).

Now we have found the total costs in the period of study for each sequence at a common date 1971, and we are able to compare one another and find out if there is any significant difference and how much this is.

As you can see from Tables nºs. 3.21. and 3.23. the total present value for each sequence was:

	Total Present Value (Jan. 1971) (in millions of US$)
Sequence A	P = 1424.33
Sequence B	P = 1341.46
Difference	D = 82.87

We can say then that going from Sequence A of power development to Sequence B we save 83 million US$ which certainly represents a considerable amount of money. We conclude then that Sequence B of power development is cheaper and more attractive.

Table nº 3.2. System Composition of Sequence A

Year (1)	Peak Requ. (2)	Additions at the end of the year (3)	Additions (4)	Total Inst. Capacity (5)
		Existing in 1970		2050
1971	1250	Jupiá 300	300	2350
1972	1590			2350
1973	1960	Ilha Solteira 480 + Jupiá 200	680	3030
1974	2350	Ilha Solteira 480	480	3510
1975	2970	Ilha Solteira 480	480	3990
1976	3420	Ilha Solteira 320 + Capivara 320	640	4630
1977	3920	Capivara 320 + Promissão 210	530	5160
1978	4460	Thermal 200	200	5360
1979	5050	Ilha Solteira 320 + Thermal 400	720	6080
1980	5860	+ Água Vermelha 690	690	6770
1981	6700	Ilha Solteira 320 + Taq.250 + Canoas 260 + Pir.120	950	7720
1982	7620	Ilha Solteira 320 Ilha Gde. 640	960	8680
1983	8620	Ilha Solteira 320 + Água Vermelha 230 + Taq. 80 + Ilha Grande 480	1110	9790
1984	9700	Ilha Solteira 160 + Água Vermelha 460 + Ilha Grande 480	1100	10890
1985	10780	Nuclear 1000 + Ilha Grande 320	1320	12210
1986	12040	Nuclear 1000 Ilha Grande 320	1320	13530
1987	13430	Nuclear 1000 Ilha Grande 480	1480	15010
1988	14930	Nuclear 1000 Ilha Grande 640	1640	16650
1989	16560	Nuclear 1000 + Thermal 1000	2000	18650
1990	18330	Nuclear 1000 + + Ilha Grande 480	1480	20130

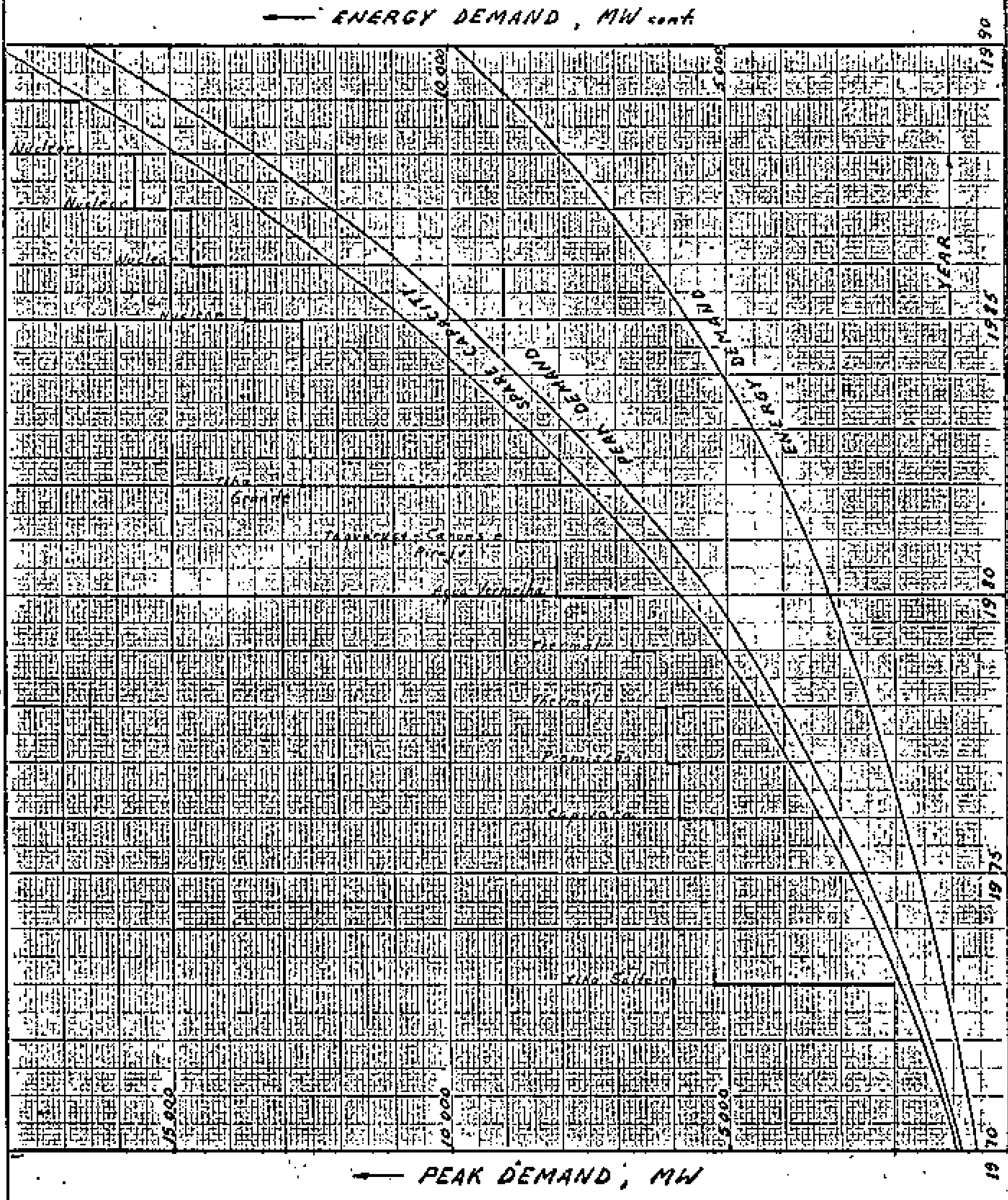
Col.(1). Shows the load years.
Col.(2). shows the total peak requirement for every load year. The installed capacity in 1970 is 2050 MW. The Figures are listed in MW.
Col.(3). shows the proposed additions to the system. The figure indicates the capacity installed at the plant on that year in MW. The total installed capacity of each plant is the sum of all the figures.
Col.(4). shows the total capacity additions per year in MW.
Col.(5). shows the total installed capacity of the system on each year in MW.

Table nº 3.3. System Composition of Sequence B'

Year (1)	Peak Requ. (2)	Additions at the end of the year (3)	Additions (4)	Total Inst. Capacity (5)
		Existing in 1970		2050
1971	1250	Jupia 300	300	2350
1972	1590		-	2350
1973	1960	Capivara 320	320	2670
1974	2350	Capivara 160 + Agua Verm. 230	390	3060
1975	2970	Capivara 160 + Agua Verm. 345	505	3565
1976	3420	Canoas 170 + Agua Verm. 230 + Piraju 120	520	4085
1977	3920	Canoas 90 + + Taqua. 250 + Prom. 140	480	4565
1978	4460	Ilha Solteira 320 + Jupiã 200 + Taqua. 80 + Prom. 70	670	5235
1979	5050	Ilha Solteira 640 + Agua Verm. 230	870	6105
1980	5860	Ilha Solteira 640 + Agua Verm. 115	755	6860
1981	6700	Ilha Solteira 160 + Agua Verm. 230 + Thermal 600	990	7850
1982	7620	Ilha Solteira 320 + Ilha Grande 640	960	8810
1983	8620	Ilha Solteira 480 + Ilha Grande 640	1120	9930
1984	9700	Ilha Solteira 320 + Ilha Grande 640	960	10890
1985	10780	Ilha Solteira 160 + Ilha Grande 160 + Nuclear 1000	1320	12210
1986	12040	Ilha Solteira 160 + Ilha Grande 160 + Nuclear 1000	1320	13530
1987	13430	Ilha Grande 480 + Nuclear 1000	1480	15010
1988	14930	Ilha Grande 640 + Nuclear 1000	1640	16650
1989	16560	Thermal 1000 + Nuclear 1000	2000	18650
1990	18330	Ilha Grande 480 + Nuclear 1000	1480	20130

Col. (1) shows the load years.
Col. (2) shows the total peak requirement for every load year. The installed capacity in 1970 is 2050 MW. The figures are listed in MW.
Col. (3) shows the proposed additions to the system. The figure indicates the capacity installed at the plant on that year in MW. The total installed capacity of each plant is the sum of all the giures.
Col. (4) shows the total capacity additions per year in MW.
Col. (5) shows the total installed capacity of the system on each year in MW.

CESP'S LOAD FORECAST — LOW RATE

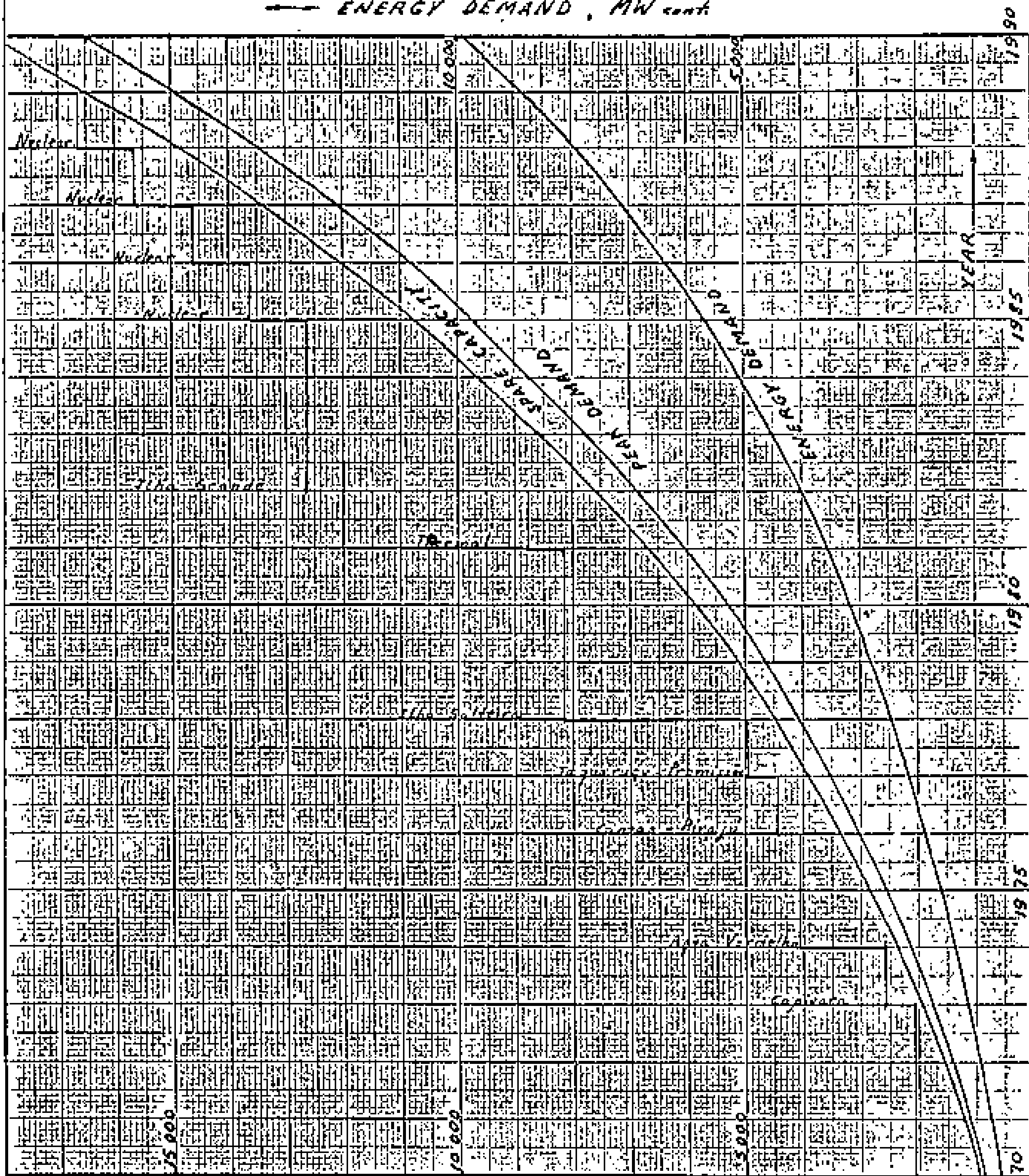


SYSTEM COMPOSITION

SEQUENCE A

FIGURE nº 3.1. a)

CESP'S LOAD FORECAST LOW RATE



SYSTEM COMPOSITION.

SEQUENCE B

FIGURE nº 3.1. b)

Table nº 3.5. CESP's Load Forecast - Low Rate

Month	% of en. to av. month (1)		Load Year 1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	Month
		Av.monthly en. demand (2)	770	970	1200	1440	1660	1910	2190	2490	2820	3110	
Jan.	90.7		700	880	1090	1300	1500	1730	1990	2260	2560	2810	Jan.
Feb.	93.9		720	910	1130	1350	1560	1790	2060	2340	2650	2920	Feb.
March	95.4		735	925	1140	1370	1580	1820	2090	2370	2690	2960	March
April	95.9		738	930	1150	1380	1590	1830	2100	2380	2700	2980	April
May	99.7		767	965	1195	1430	1655	1900	2180	2480	2810	3100	May
June	100.8		775	980	1210	1450	1670	1920	2210	2510	2820	3120	June
July	103.3		795	1000	1240	1490	1710	1970	2260	2570	2910	3200	July
Aug.	105.6		813	1025	1270	1520	1750	2020	2310	2630	2980	3280	Aug.
Sept.	104.9		806	1018	1260	1510	1740	2000	2300	2610	2960	3260	Sept.
Oct.	104.2		802	1010	1250	1500	1730	1990	2280	2600	2950	3240	Oct.
Nov.	102.7		790	996	1230	1480	1700	1960	2250	2560	2900	3190	Nov.
Dec.	101.7		783	986	1220	1460	1690	1940	2230	2530	2870	3160	Dec.

Col.(1). lists the seasonal load factor variation in per cent of energy to average month.
Source: CANAMBRA Report Vol.VII appendix 15.

Row (2), lists the average monthly energy demand in MWcont.

Cont. ...

Table nº 3.5. CESP's Load Forecast - Low Rate

... Cont. 2.

Month	% of en. to av. month (1)	Av.monthly en. demand (2)	Load Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Month
			3560	4040	4570	5150	5710	6390	7120	7910	8780	9720	
Jan.	90.7		3220	3660	4150	4670	5180	58000	6450	7160	7960	8800	Jan.
Feb.	93.9		3340	3780	4290	4840	5360	6000	6680	7420	7240	9120	Feb.
March	95.4		3400	3850	4360	4910	5450	6100	6780	7550	8370	9260	March
April	95.9		3410	3870	4380	4930	5470	6120	6820	7590	8420	9310	April
May	99.7		3550	4030	4550	5130	5700	6370	7100	7880	8750	9700	May
June	100.8		3580	4070	4600	5180	5750	6440	7160	7960	8850	9800	June
July	103.3		3680	4170	4720	5320	5900	6600	7350	8160	9070	10050	July
Aug.	105.6		3760	4260	e830	5430	6040	6750	7510	8350	9270	10250	Aug.
Sept.	104.9		3730	4230	4790	5400	5980	6700	7450	8290	9200	10190	Sept.
Oct.	104.2		3710	4210	4760	5370	5950	6650	7420	8250	9150	10120	Oct.
Nov.	102.7		3660	4150	4690	5280	5860	6560	7300	8120	9020	9960	Nov.
Dec.	101.7		3620	4110	4650	5240	5810	6500	7250	8050	8940	9880	Dec.

Col.(1). lists the seasonal load factor variation in per cent of energy to average month.
Source: CANAMBRA Report Vol.VII appendix 15.

Row (2). lists the average monthly energy demand in MWcont.

Table nº 3.6. Available Energy in the Dry Period (1954-1955) with no Regulation from Storage Reservoirs

Year (1)	Month	JURUMIRIM Natural (2)	JURUMIRIM Energy (3)	PIRAJU Natural (2)	PIRAJU Energy (3)	XAVANTES Natural (2)	XAVANTES Energy (3)	SALTO GRANDE Natural (2)	SALTO GRANDE Energy (3)
1954	J	284	73	290	120	442	245	620	61
	J	183	47	187	86	286	159	400	58
	A	134	35	137	63	202	112	277	40
	S	118	30	121	55	178	99	242	35
	O	160	41	163	75	227	126	301	44
	N	103	27	105	48	157	87	214	31
	D	100	26	102	47	159	88	222	32
1955	J	198	51	202	93	276	155	361	52
	F	130	33	133	61	185	103	245	36
	M	222	57	227	104	312	173	411	60
	A	193	50	197	90	287	159	391	57
	M	137	35	140	64	198	110	264	39
	J	136	35	139	64	213	118	296	43
	J	153	39	156	72	230	128	314	46
	A	126	32	129	105	194	108	269	39
	S	143	37	146	67	202	113	267	39
	O	110	28	112	51	158	88	210	31
	N	152	39	155	71	222	123	300	44
	D	104	27	106	49	166	92	233	34

Col.(1). The period shown in the table is the most critical period on record.
Col.(2). lists the natural flows in cubic meter per second at the hydro sites.
Col.(3). lists the energy production expressed in MWmonth. Col.(3) is obtained from the multiplication of the Coefficient listed in Table nº 3.9. by the flows in Col.2.

Cont. ...

Table nº 3.6 Available Energy in the Dry Period (1954-1955) with no Regulation from Storage Reservoirs

... Cont. 2.

Year (1)	Month	CANOAS Natural (2)	CANOAS Energy (3)	CAPIVARA Natural (2)	CAPIVARA Energy (3)	TAQUARUÇU Natural (2)	TAQUARUÇU Energy (3)
1954	J	883	245	2350	640	2442	330
	J	537	149	1227	475	1276	270
	A	343	95	777	300	807	171
	S	292	81	601	232	624	132
	O	359	100	801	310	832	176
	N	256	71	572	221	594	126
	D	262	73	467	181	485	103
1955	J	412	114	648	251	674	143
	F	284	78	450	174	467	99
	M	484	134	760	294	789	167
	A	467	130	732	283	761	161
	M	306	85	592	229	616	130
	J	373	104	1197	463	1244	264
	J	400	111	1463	566	1520	322
	A	353	98	814	314	846	179
	S	335	93	848	328	881	187
	O	254	70	516	200	536	114
	N	377	105	831	322	864	183
	D	288	80	579	224	602	127

Col.(1). The period shown in the table is the most critical period on record.
Col(2). lists the natural flows in cubic meter per second at the hydro sites.
Col.(3). lists the energy production expressed in MWmonth. Col.(3) is obtained from the multiplication of the Coefficient listed in Table nº 3.9. by the flows in Col. 2.

Cont. ...

Table nº 3.6. Available Energy in the Dry Period (1954-1955) with no Regulation from Storage Reservoirs

... Cont. 3.

Year (1)	Month	BARRA BONITA Natural (2)	BARRA BONITA Energy (3)	BARIRI Natural (2)	BARIRI Energy (3)	IBITINGA Natural (2)	IBITINGA Energy (3)	PROMISSÃO Natural (2)	PROMISSÃO Energy (3)
1954	J	212	35	240	46	325	62	444	88
	J	150	25	169	32	227	43	308	61
	A	111	18	125	24	167	32	226	45
	S	97	16	107	20	136	26	177	35
	O	108	17	118	22	149	28	193	38
	N	97	16	106	20	132	25	168	33
	D	129	21	144	27	188	36	249	50
1955	J	344	57	369	71	444	85	548	110
	F	172	28	184	35	219	42	267	53
	M	235	39	261	50	339	65	448	90
	A	177	29	194	37	246	47	318	63
	M	119	20	130	25	164	31	211	42
	J	117	19	130	25	169	32	224	45
	J	108	18	117	22	143	27	180	36
	A	102	17	109	21	131	25	161	32
	S	118	19	129	25	162	31	208	41
	O	92	15	99	19	120	23	149	30
	N	174	29	187	36	225	43	278	55
	D	223	37	238	45	282	54	343	69

Col.(1). The period shown in the table is the most critical period on record.
Col.(2). lists the natural flows in cubic meter per second at the hydro sites.
Col.(3). lists the energy production expressed in MWmonth. Col. (3) is obtained from the multiplication of the Coefficient listed in Table nº 3.9. by the flows in Col. 2.

Cont. ...

Table nº 3.6. Available Energy in the Dry Period (1954-1955) with no Regulation from Storage Reservoirs

... Cont. 4.

Year (1)	Month	ILHA SOLTEIRA		JUPIÁ		ÁGUA VERMELHA		ILHA GRANDE	
		Natural (2)	Energy (3)	Natural (2)	Energy (3)	Natural (2)	Energy (3)	Natural (2)	Energy (3)
1954	J	2676	980	3415	665	1273	579	9050	2630
	J	2052	750	2576	503	1173	534	5260	950
	A	1863	682	2288	457	1137	517	3720	1080
	S	1674	613	2040	398	1086	494	3280	955
	O	1589	582	1977	386	1112	506	3570	1040
	N	2162	790	2531	495	1086	494	3610	1050
	D	3327	1220	3806	744	1226	557	4640	1350
1955	J	4462	1630	5342	1040	1461	665	6760	1970
	F	3959	1450	4470	875	1260	573	6500	1890
	M	3805	1395	4582	896	1511	687	6440	1870
	A	4227	1546	4816	940	1404	639	6830	1985
	M	2676	980	3102	606	1175	535	4500	1310
	J	2244	822	2690	526	1154	525	6490	1890
	J	1918	701	2285	446	1119	508	5800	1690
	A	1769	647	2114	413	1123	512	3800	1105
	S	1662	609	2058	402	1105	503	4210	1225
	O	1911	700	2239	437	1141	520	3190	930
	N	2704	990	3201	625	1255	571	5040	1465
	D	4252	1560	4816	940	1306	594	6190	1800

Col.(1). The period shown in the table is the most critical period on record.
Col.(2). lists the natural flows in cubic meter per second at the hydro sites.
Col.(3). lists the energy production expressed in MWmonth. Col. (3) is obtained from the multiplication of the Coefficient listed in Table nº 3.9. by the flows in Col. 2.

Cont. ...

Table nº 3.6.Available Energy in the Dry Period (1954-1955) with no Regulation from Storage Reservoirs.

... Cont. 5.

Year (1)	Month	GRAMINHA Natural (2)	GRAMINHA Energy (3)	EUCLIDES DA CUNHA (*) and LIMOEIRO Natural (2)	EUCLIDES DA CUNHA (*) and LIMOEIRO Energy (3)	JAGUARY Natural (2)	JAGUARY Energy (3)
1954	J	28	20	48	46		24
	J	20	14	35	34		24
	A	16	11	28	27		20
	S	13	9.5	24	23		21
	O	15	11	26	25		24
	N	13	9.5	22	21		23
	D	33	24	59	57		24
1955	J	56	41	95	92		24
	F	32	23	52	50		24
	M	55	40	89	87		24
	A	50	37	83	81		24
	M	27	20	44	43		24
	J	24	17	39	38		23
	J	18	13	30	29		18
	A	17	12	27	26		19
	S	15	11	25	24		18
	O	15	11	27	26		18
	N	21	15	35	34		24
	D	100	68	164	119		24

Col.(1). The period shown in the table is the most critical period on record.
Col.(2). lists the natural flows in cubic meter per second at the hydro sites.
Col(3). lists the energy production expressed in MWmonth. Col. (3) is obtained from the multiplication of the Coefficiènt listed in Table nº 3.9. by the flows in Col.

(*) Note: Since there is no incremental flow between these power plants we considered them together.

Table nº 3.7. Thermal Energy Requirements for Sequence A, for Dry period Conditions

Year (1)	Month	1971 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1972 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1954	J	775	1218	-	-	full	980	1363	-	-	full
	J	795	925	-	-	"	1000	925	36	- 39	- 39
	A	813	766	36	- 11	- 11	1025	766	36	-223	- 262
	S	806	666	36	-104	-115	1018	666	36	-316	- 578
	O	802	710	36	- 56	-171	1010	710	36	-264	- 842
	N	790	741	36	- 13	-184	996	741	36	-219	-1061
	D	783	1065	-	+184	full	986	1065	36	+115	- 946
1955	J	700	1514	-	-	full	880	1654	36	+810	- 136
	F	720	1235	-	-	"	910	1235	-	+136	full
	M	735	1477	-	-	"	925	1477	-	-	"
	A	738	1407	-	-	"	930	1447	-	-	"
	M	767	1938	-	-	"	965	1938	-	-	"
	J	775	863	-	-	"	980	863	36	- 81	- 81
	J	795	737	36	- 22	- 22	1000	737	36	-227	- 308
	A	813	713	36	- 64	- 86	1025	713	36	-276	- 584
	S	806	741	36	- 29	-115	1018	741	36	-241	- 825
	O	802	668	36	- 78	-193	1010	688	36	-286	-1111
	N	790	998	-	+193	full	996	998	36	+ 38	-1073
	D	783	1386	-	-	"	986	1426	36	+676	- 397
Sum total (7)				144					288		

Col.(1) The period shown in the table is the most critical period on record.
Col.(2) Lists the required energy in the load year stated above, in MWmonth.
Col.(3) Lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.
Col.(4) Lists the thermal energy production, in MWmonth.
Col.(5) shows the difference between cols. (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6) shows the deficiency in the storage reservoir in MWmonth.
Row (7) Sum total of Col.(4) correspondent to the year 1955.

Cont. ...

Table nº 3.7. Thermal Energy Requirements for Sequence A, for Dry Period Conditions

... Cont. 2.

Year	Month (1)	1973 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1974 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1954	J	1210	1363	-	-	full	1450	1843	-	-	-
	J	1240	925	36	-279	-279	1490	1405	36	- 49	- 49
	A	1270	766	36	-468	-747	1520	1246	36	-238	- 287
	S	1260	666	36	-558	-1305	1510	1146	36	-328	- 615
	O	1250	710	36	-504	-1809	1500	1190	36	-274	- 889
	N	1230	741	36	-453	-2262	1480	1221	36	-223	-1112
	D	1220	1065	36	-119	-2381	1460	1545	36	+121	- 991
1955	J	1090	1654	36	+600	-1781	1300	2134	36	+870	- 121
	F	1130	1235	36	+141	-1640	1350	1715	-	+121	full
	M	1140	1477	36	+373	-1267	1370	1957	-	-	"
	A	1150	1447	36	+333	- 934	1380	1927	-	-	"
	M	1195	1938	36	+779	- 155	1430	2418	-	-	"
	J	1210	863	36	-311	- 466	1450	1343	36	- 71	- 71
	J	1240	737	36	-467	- 933	1490	1217	36	-237	- 308
	A	1270	713	36	-521	-1454	1520	1193	36	-291	- 599
	S	1260	741	36	-483	-1937	1510	1221	36	-253	- 852
	O	1250	688	36	-526	-2463	1500	1168	36	-296	-1148
	N	1230	998	36	-196	-2659	1480	1478	36	+ 34	-1114
	D	1220	1426	36	+242	-2417	1460	1906	36	+482	- 632
Sum total (7)				432					288		

Col.(1) Therperiod shown in the table is the most critical period on record.
Col.(2) Lists the required energy in the load year stated above, in MWmonth.
Col.(3) lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.
Col.(4) Lists the thermal energy production, in MWmonth.
Col.(5) Shows the difference between cols. (3+4) and (2). Negative signs indicate flow dificiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6) shows the deficiency in the storage reservoir in MWmonth.
Row (7) Sum total of Col.(4) correspondent to the year 1955.

Cont. ...

Table nº 3.7. Thermal Energy Requirements for Sequence A, for Dry Period Conditions

... Cont. 3.

Year (1)	Month	1975 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1976 Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1954	J	1670	2323	-	-	-	1920	2343	-	-	-
	J	1710	1657	35	-	-	1970	1675	-	-	-
	A	1750	1448	36	-266	- 266	2020	1448	36	- 536	- 536
	S	1740	1279	36	-425	- 691	2000	1279	36	- 685	-1221
	O	1730	1292	36	-402	-1093	1990	1292	36	- 662	-1883
	N	1700	1531	36	-133	-1226	1960	1531	36	- 393	-2276
	D	1690	2025	36	+371	- 855	1940	2285	36	+ 381	-1895
1955	J	1500	2614	-	+855	full	1730	3094	36	+1400	- 495
	F	1560	2195	-	-	"	1790	2675	-	+ 495	full
	M	1580	2437	-	-	"	1820	2872	-	-	"
	A	1590	2407	-	-	"	1830	2887	-	-	"
	M	1655	2898	-	-	"	1900	2918	-	-	"
	J	1670	1685	-	-	"	1920	1685	36	- 199	- 199
	J	1710	1438	36	-236	- 236	1970	1438	36	- 496	- 695
	A	1750	1360	36	-354	- 590	2020	1360	36	- 724	-1419
	S	1740	1350	36	-354	- 944	2000	1350	36	- 614	-2033
	O	1730	1388	36	-306	-1250	1990	1388	36	- 566	-2599
	N	1700	1958	36	+294	- 956	1960	1988	36	+ 64	-2535
	D	1690	2386	36	+532	- 424	1940	2866	36	+ 962	-1573
Sum total (7)				216					288		

Col.(1) The period shown in the table is the most critical period on record.
Col.(2) lists the required energy in the load year stated above, in MWmonth.
Col.(3) lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.
Col.(4) lists the thermal energy production, in MWmonth.
Col.(5) shows the difference between cols. (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6) shows the deficiency in the storage reservoir in MWmonth.
Row (7) Sum total of Col.(4) correspondent to the year 1955.

Cont. ...

Table nº 3.7. Thermal Energy Requirements for Sequence A, for Dry Period Conditions

... Cont. 4

Year (1)	Month	1977 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1978 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1954	J	2210	2663	-	-	-	2510	3071	-	-	-
	J	2260	1995	36	- 229	- 229	2570	2211	36	- 323	- 323
	A	2310	1748	36	- 526	- 755	2630	1793	36	- 801	-1124
	S	2300	1511	36	- 753	-1508	2610	1546	36	-1028	-2152
	O	2280	1602	36	- 642	-2150	2600	1640	36	- 924	-3076
	N	2250	1752	36	- 462	-2612	2560	1785	36	- 739	-3815
	D	2230	2466	36	+ 272	-2340	2530	2516	36	+ 22	-3793
1955	J	1990	3535	36	+1581	- 759	2260	3645	36	+1421	-2372
	F	2060	2859	-	+ 759	full	2340	2912	36	+ 608	-1764
	M	2090	3166	-	-	"	2370	3256	36	+ 922	- 842
	A	2100	3276	-	-	"	2380	3339	-	+ 842	full
	M	2180	3147	-	-	"	2480	3189	-	-	"
	J	2210	2005	36	- 169	- 169	2510	2193	36	- 281	- 281
	J	2260	1758	36	- 466	- 635	2570	2040	36	- 494	- 775
	A	2310	1674	36	- 600	-1235	2630	1706	36	- 888	-1663
	S	2300	1670	36	- 594	-1829	2610	1719	36	- 855	-2518
	O	2280	1588	36	- 656	-2485	2600	1618	36	- 946	-3464
	N	2250	2310	36	+ 96	-2389	2560	2367	36	- 157	-3621
	D	2230	3210	36	+ 16	-2373	2530	3279	36	+ 785	-2836
Sum total (7)				288					360		

Col.(1) The period shown in the table is the most critical period on record.
Col.(2) Lists the required energy in the load year stated above, in MWmonth.
Col.(3) Lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.
Col.(4) Lists the thermal energy production, in MWmonth.
Col.(5) shows the difference between cols (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6) shows the deficiency in the storage reservoir in MWmonth.
Row (7) Sum total of Col.(4) correspondent to the year 1955.

Cont. ...

Table 3.7. Thermal Energy Requirements for Sequence A, for Dry Period Conditions

... Cont. 5.

Year (1)	Month	1979 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1980 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1954	J	2820	3071	-	-	-	3120	3071	49	-	-
	J	2910	2211	216	- 483	-483	3200	2211	576	- 413	- 413
	A	2980	1793	216	- 971	-1454	3280	1793	576	- 911	-1324
	S	2960	1546	216	-1198	-2652	3260	1546	576	-1138	-2462
	O	2950	1640	216	-1094	-3746	3240	1640	576	-1024	-3486
	N	2900	1785	216	- 899	-3645	3190	1785	576	- 829	-4315
	D	2870	2516	216	- 138	-3783	3160	2516	576	- 68	-4383
1955	J	2560	3645	216	+1301	-2482	2810	3645	576	+1411	-2972
	F	2650	2912	216	+ 478	-2004	2920	2912	576	+ 568	-2404
	M	2690	3256	216	+ 782	-1222	2960	3256	576	+ 872	-1532
	A	2700	3339	216	+ 855	- 367	2980	3339	576	+ 935	- 597
	M	2810	3189	-	+ 367	full	3100	3189	508	+ 597	full
	J	2820	2193	216	- 411	- 411	3120	2193	576	- 351	- 351
	J	2910	2040	216	- 654	-1065	3200	2040	576	- 584	- 935
	A	2980	1706	216	-1058	-2123	3280	1706	576	- 998	-1933
	S	2960	1719	216	-1025	-3148	3260	1719	576	- 965	-2898
	O	2950	1618	216	-1116	-4264	3240	1618	576	-1046	-3944
	N	2900	2367	216	- 317	-4581	3190	2367	576	- 247	-4191
	D	2870	3279	216	+ 625	-3956	3160	3279	576	+ 695	-3496
Sum total (7)				2,376					6,844		

Table nº 3.7. Thermal Energy Requirements for Sequence A, for Dry Period Conditions

....Cont..6.

Year (1)	Month	1981 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1982 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1954	J	3580	3650	-	-	-	4070	4265	-	-	-
	J	3680	2745	576	- 359	- 359	4170	3230	576	- 364	- 364
	A	3760	2310	576	- 874	-1233	4260	2639	576	-1045	-1409
	S	3730	2040	576	-1114	-2347	4230	2308	576	-1346	-2755
	O	3710	2146	576	- 988	-3335	4210	2597	576	-1037	-3792
	N	3660	2279	576	- 805	-4140	4150	2524	576	-1050	-4842
	D	3620	3073	576	+ 29	-4111	4110	3296	576	- 238	-5080
1955	J	3220	4310	576	+1666	-2445	3660	4660	576	+1516	-3504
	F	3340	3485	576	+ 721	-1724	3780	3723	576	+ 519	-2985
	M	3400	3943	576	+1119	- 605	3850	4348	576	+1074	-1911
	A	3410	3978	37	+ 605	full	3870	4359	576	+1065	- 846
	M	3550	3724	-	-	"	4030	4003	576	+ 549	- 297
	J	3580	2718	576	- 286	- 286	4070	3136	576	- 358	- 655
	J	3680	2548	576	- 556	- 842	4170	2981	576	- 613	-1268
	A	3760	2218	576	- 996	-1838	4260	2600	576	-1084	-2352
	S	3730	2222	576	- 932	-2770	4230	2569	576	-1085	-3437
	O	3710	2138	576	- 996	-3766	4210	2373	576	-1261	-4698
	N	3660	2938	576	- 146	-3912	4150	3297	576	+ 277	-4421
	D	3620	3873	576	+ 829	-3083	4110	4129	576	+ 595	-3826
Sum.total	(7)			5,797					6,912		

Table nº 3.7 Thermal Energy Requirements for Sequence A, for Dry Period Conditions

Cont. 7.

Year (1)	Month	1983 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1984 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1954	J	4600	4905	-	-	-	5180	5465	-	-	-
	J	4720	3870	576	- 274	- 274	5320	4200	576	- 544	- 544
	A	4830	3279	576	- 975	-1249	5430	3719	576	-1135	-1679
	S	4790	2948	576	-1266	-2515	5400	3263	576	-1561	-3240
	O	4760	3237	576	- 947	-3462	5370	3637	576	-1157	-4397
	N	4690	3164	576	- 950	-4412	5280	3574	576	-1130	-5527
	D	4650	3936	576	- 138	-4550	5240	4416	576	- 248	-5775
1955	J	4150	5300	576	+ 1726	-2824	4670	5780	576	+1686	-4089
	F	4290	4363	576	+ 649	-2175	4840	4843	576	+ 579	-3510
	M	4360	4988	576	+ 1204	- 971	4910	5468	576	+1134	-2376
	A	4380	4999	352	+ 971	full	4930	5479	576	+1125	-1251
	M	4550	4643	-	-	full	5130	5123	576	+ 569	- 682
	J	4600	3776	576	- 248	- 248	5180	5270	576	+ 666	- 16
	J	4720	3621	576	- 523	- 771	5320	4173	576	- 571	- 587
	A	4830	3240	576	-1014	-1785	5430	3705	576	-1149	-1736
	S	4790	3209	576	- 1005	-2790	5400	3689	576	-1135	-2871
	O	4760	3013	576	- 1171	-3961	5370	3303	576	-1451	-4322
	N	4690	3937	576	- 177	-4138	5280	4417	576	- 287	-4609
	D	4650	4769	576	+ 695	-3443	5240	5249	576	+ 585	-4024
Sum total (7)				6,112					6,912		

Table nº 3.7.Thermal Energy Requirements for Sequence A, for Dry Period Conditions

Cont. 8.

Year (1)	Month	1985 Req. Energy (2)	Avail. Hydro. (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1986 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1954	J	5750	5945	-	-	-	6440	6265	175	-	-
	J	5900	4200	576	-1124	-1124	6600	4200	1426	- 974	- 974
	A	6040	3719	576	-1745	-2869	6750	3719	1426	-1605	-2579
	S	5980	3263	576	-2141	-5010	6700	3263	1426	-2011	-4590
	O	5950	3637	576	-1737	-6747	6650	3637	1426	-1587	-6177
	N	5860	3574	576	-1710	-8457	6560	3574	1426	-1560	-7737
	D	5810	4646	576	- 588	-9045	6500	4646	1426	- 428	-8165
1955	J	5180	6260	576	+1656	-7389	5800	6580	1426	+2206	-5959
	F	5360	5323	576	+ 539	-6850	6000	5613	1426	+1039	-4920
	M	5450	5948	576	+1074	-5776	6100	6218	1426	+1544	-3376
	A	5470	5979	576	+1085	-4691	6120	6299	1426	+1605	-1771
	M	5700	5313	576	+ 189	-4512	6320	5313	1426	+ 369	-1402
	J	5750	4750	576	- 424	-4936	6440	5040	1426	+ 26	-1376
	J	5900	4653	576	- 671	-5607	6600	4743	1426	- 431	-1807
	A	6040	3705	576	-1759	-7366	6750	3705	1426	-1619	-3426
	S	5980	3794	576	-1610	-8976	6700	3794	1426	- 480	-3906
	O	5950	3303	576	-2071	-11047	6650	3303	1426	-1921	-5827
	N	5860	4762	576	- 522	-11569	6560	4762	1426	- 372	-6199
	D	5810	5729	576	+ 495	-11074	6500	5929	1426	+ 855	-5344
Sum total (7)				6,912					17,112		

Table nº 3.7. Thermal Energy Requirements for Sequence A, for Dry Period Conditions

Cont. 9.

Year (1)	Month	1987 Req. Energy (2)	Avail. Hydro. (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1988 Req. Energy (2)	Avail. Hydro. (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1954	J	7160	6585	575	-	-	7960	6975	985	-	-
	J	7350	4200	2276	- 874	- 874	7160	4200	3126	- 834	- 834
	A	7510	3719	2276	-1515	-2389	8350	3719	3126	-1505	-2339
	S	7450	3263	2276	-1911	-4300	8290	3263	3126	-1901	-4240
	O	7420	3637	2276	-1507	-5807	8250	3637	3126	-2487	-6727
	N	7300	3574	2276	-1450	-7257	8120	3574	3126	-1420	-8147
	D	7250	4646	2276	- 328	-7585	8050	4646	3126	-278	-8425
1955	J	6450	6630	2276	+2456	-5129	7160	6630	3126	+2596	-5829
	F	6680	5613	2276	+1209	-3920	7420	5613	3126	+1319	-4510
	M	6780	6218	2276	+1714	-2206	7550	6218	3126	+1794	-2716
	A	6820	6364	2276	+1820	- 386	7590	6364	3126	+1900	- 816
	M	7100	5313	2173	+ 386	full	7880	5313	3126	+ 559	- 257
	J	7160	5040	2120	-	full	7960	5040	3126	+ 206	- 51
	J	7350	4743	2276	- 331	- 331	8160	4743	3126	- 291	- 342
	A	7510	3705	2276	-1529	-1860	8350	3705	3126	-1519	-1861
	S	7450	3794	2276	-1380	-2240	8290	3794	3126	-1370	-3231
	O	7420	3303	2276	-1841	-4081	8250	3303	3126	-1821	-5052
	N	7300	4762	2276	- 262	-4343	8120	4762	3126	- 232	-5284
	D	7250	5929	2276	+ 955	-3388	8050	5929	3126	+1005	-4279
Sum total	(7)			27,053					37,512		

Table nº 3.7. Thermal Energy Requirements for Sequence A, for Dry Period Conditions

... Cont. 10.

Year (1)	Month	1989 Req. Energy (2)	Avail. Hydro. (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1990 Req. Energy (2)	Avail. Hydro. (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1954	J	8850	6975	1875	-	-	9800	6975	2825	-	-
	J	9070	4200	3976	- 894	- 894	10050	4200	5726	- 124	- 124
	A	9270	3919	3976	-1575	-2469	10250	3719	5726	- 805	- 929
	S	9200	3263	3976	-1961	-4430	10190	3263	5726	-1201	-2130
	O	9150	3637	3976	-1537	-5967	10120	3637	5726	- 757	-2887
	N	9020	3574	3976	-1470	-7437	9960	3574	5726	- 660	-3547
	D	8940	4646	3976	- 318	-7757	9880	4646	5726	- 492	-4039
1955	J	7960	6630	3976	+2646	-5111	8800	6630	7526	+3556	- 483
	F	8240	5613	3976	+1349	-3762	9120	5613	3990	+ 483	full
	M	8370	6218	3976	+1824	-1938	9260	6218	3042	-	full
	A	8420	6364	3976	+1920	- 18	9310	6364	2946	-	full
	M	8750	5313	3455	+ 18	full	9700	5313	4387	-	full
	J	8850	5040	3810	-	full	9800	5040	4760	-	full
	J	9070	4743	3976	- 351	- 351	10050	4743	5307	-	full
	A	9270	3705	3976	-1589	-1940	10250	3705	5726	- 819	- 819
	S	9200	3794	3976	-1430	-3370	10190	3794	5726	- 670	-1489
	O	9150	3303	3976	-1871	-5241	10120	3303	5726	-1091	-2580
	N	9020	4762	3976	- 282	-5523	9960	4762	5726	- 528	-3108
	D	8940	5929	3976	+ 965	-4558	9880	5929	5726	+1775	-1333
Sum total (7)				47,025					58,788		

Table nº3.8 - Thermal Energy Requirements for Sequence B, for Dry Period Conditions

Year (1)	Month	1974 Req. Energy (2)	Avail. Hydro. (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1975 Req. Energy (2)	Avail. Hydro. (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1954	M	1430	1871	-	-	-	1655	2261	-	-	-
	J	1450	1675	-	-	-	1670	2065	-	-	-
	J	1490	1245	36	- 209	- 209	1710	1630	36	- 44	- 44
	A	1520	1066	36	- 418	- 627	1750	1296	36	- 418	- 462
	S	1510	898	36	- 576	-1203	1740	1128	36	- 576	-1038
	O	1500	1020	36	- 444	-1647	1730	1250	36	- 444	-1482
	N	1480	962	36	- 482	-2129	1700	1192	36	- 472	-1954
	D	1460	1246	36	- 178	-2307	1690	1476	36	- 178	-2132
1955	J	1300	1905	36	+ 641	-1666	1500	2135	36	+ 671	-1461
	F	1350	1409	36	+ 95	-1571	1560	1639	36	+ 115	-1346
	M	1370	1771	36	+ 437	-1134	1580	2001	36	+ 457	- 889
	A	1380	1730	36	+ 386	- 748	1590	1960	36	+ 406	- 483
	M	1430	2167	31	+ 748	full	1655	2397	-	+ 483	full
	J	1450	1183	36	- 231	- 231	1670	1556	36	- 78	- 78
	J	1490	1057	36	- 397	- 628	1710	1447	36	- 227	- 305
	A	1520	1027	36	- 457	-1085	1750	1257	36	- 457	- 762
	S	1510	1061	36	- 413	-1498	1740	1299	36	- 405	-1167
	O	1500	888	36	- 576	-2074	1730	1118	36	- 576	-1743
	N	1480	1318	36	- 126	-2200	1700	1550	36	- 114	-1857
	D	1460	1650	36	+ 226	-1974	1690	1880	36	+ 226	-1631
Sum total (7)				427					396		

Col.(1). The period shown in the Table is the most critical period on record.
Col.(2) lists the required energy in the load year stated above, in MWmonth.
Col.(3) lists the available energy from the hydro plants on that corresponding load year with no regulation from storage reservoirs.
Col.(4) lists the thermal energy production, in MWmonth.
Col.(5) shows the difference between Cols. (3)+(4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6) shows the deficiency in the storage reservoir, in MWmonth.
Row (7) Sum total of Col. (4) correspondent to the year 1955.

Note: In the years 1971, 1972 and 1973, Sequence B has the same composition of Sequence A, and so the thermal energy requirements are same.(See Table nº 3.7).

Table nº 3.8. Thermal Energy Requirements for Sequence B, for Dry Period Conditions

... Cont. 2.

Year (1)	Month	1976 Req. Energy (2)	Avail. Hydro. (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1977 Req. Energy (2)	Avail. Hydro. (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1954	M	1900	2766	-	-	-	2180	3112	-	-	-
	J	1920	2570	-	-	-	2210	2664	-	-	-
	J	1970	1934	36	-	-	2260	2169	36	- 55	- 55
	A	2020	1583	36	- 401	- 401	2310	1741	36	- 533	- 588
	S	2000	1392	36	- 572	- 973	2300	1528	36	- 836	-1424
	O	1990	1526	36	- 428	-1401	2280	1701	36	- 543	-1967
	N	1960	1456	36	- 468	-1869	2250	1575	36	- 639	-2606
	D	1940	1803	36	- 101	-970	2230	1923	36	- 271	-2877
1955	J	1730	2480	36	+ 786	-1184	1990	2777	36	+ 823	-2054
	F	1790	1982	36	+ 228	- 956	2060	2233	36	+ 9	-2045
	M	1820	2344	36	+ 560	- 396	2090	2646	36	+ 592	-1453
	A	1830	2305	-	+ 396	full	2100	2525	36	+ 461	- 992
	M	1900	2702	-	-	full	2180	2851	36	+ 707	- 285
	J	1920	1851	36	- 33	- 33	2210	2019	36	- 155	- 440
	J	1970	1811	36	- 123	- 156	2260	1994	36	- 230	- 670
	A	2020	1539	36	- 445	- 601	2310	1742	36	- 532	-1202
	S	2000	1572	36	- 392	- 993	2300	1732	36	- 532	-1734
	O	1990	1408	36	- 546	-1539	2280	1529	36	- 715	-2449
	N	1960	1891	36	- 33	-1572	2250	2067	36	- 147	-2596
	D	1940	2225	36	+ 321	-1251	2230	2373	36	+ 179	-2617
Sum total (7)				360					432		

Col.(1). The period shown in the Table is the most critical period on record.
Col.(2). lists the required energy in the load year stated above, in MWmonth.
Col.(3). lists the available energy from the hydro plants on that corresponding load year with no regulation from storage reservoirs.
Col.(4). lists the thermal energy production, in MWmonth.
Col.(5). shows the difference between Cols. (3)+(4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6). shows the deficiency in the storage reservoir, in MWmonth.
Row.(7). Sum total of Col. (4) correspondent to the year 1955.

Table nº 3.8. Thermal Energy Requirements for Sequence B, for Dry Period Conditions

... Cont. 3.

Year (1)	Month	1978 Req. Energy (2)	Avail. Hydro. (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1979 Req. Energy (2)	Avail. Hydro. (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1954	M	2480	3562	-	-	-	2810	3900	-	-	-
	J	2510	3077	-	-	-	2820	3477	-	-	-
	J	2570	2480	36	- 54	- 54	2910	2820	36	- 54	-[illegible]54
	A	2630	1957	36	- 637	- 691	2980	2277	36	- 667	- 721
	S	2610	1695	36	- 879	-1570	2960	2015	36	- 909	-1630
	O	2600	1951	36	- 649	-2219	2950	2235	36	-679	-2309
	N	2560	1734	36	- 790	-3009	2900	2054	36	- 810	-3119
	D	2530	2076	36	- 418	-3427	2870	2396	36	-438	-3557
1955	J	2260	3030	36	+ 806	-2621	2560	3350	36	+ 826	-2731
	F	2340	2385	36	+ 81	-2540	2650	2705	36	+ 91	-2640
	M	2370	2903	36	+ 569	-1971	2690	3223	36	+ 569	-2071
	A	2380	2749	36	+ 405	-1566	2700	3069	36	+ 405	-1666
	M	2480	3023	36	+ 579	- 987	2810	3343	36	+ 569	-1097
	J	2510	2328	26	- 146	-1133	2820	2648	36	- 336	-1433
	J	2570	2280	36	- 254	-1387	2910	2672	36	- 202	-1635
	A	2630	1953	36	- 641	-2028	2980	2273	36	- 671	-2306
	S	2610	1960	36	- 614	-2642	2960	2280	36	- 644	-2950
	O	2600	1673	36	- 891	-3533	2950	1993	36	- 921	-3871
	N	2560	2305	36	- 219	-3752	2900	2625	36	- 239	-4110
	D	2530	2569	36	+ 75	-3677	2870	2889	36	+ 55	-4055
Sum total	(7)			432					432		

Col.(1). The period shown in the Table is the most critical period on record.
Col.(2) lists the required energy in the load year stated above, in MWmonth.
Col.(3) lists the available energy from the hydro plants on that corresponding load year with no regulation from storage reservoirs.
Col.(4) lists the thermal energy production, in MWmonth.
Col.(5) shows the difference between Cols. (3)+(4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6) shows the deficiency in the storage reservoir, in MWmonth.
Row (7) Sum total of Col. (4) correspondent to the year 1955.

Table nº 3.8. Thermal Energy Requirements for Sequence B, for Dry Period Conditions

... Cont. 4 .

Year (1)	Month	1980 Req. Energy (2)	Avail. Hydro. (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1981 Req. Energy (2)	Avail. Hydro. (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1954	M	3100	4602	–	–	–	3550	4982	–	–	–
	J	3120	4117	–	–	–	3580	4137	–	–	–
	J	3200	3230	–	–	–	3680	3230	36	- 414	- 414
	A	3280	2639	36	- 605	- 605	3760	2639	36	-1085	-1499
	S	3260	2308	36	- 916	-1521	3730	2308	36	-1386	-2885
	O	3240	2497	36	- 707	-2228	3710	2497	36	-1177	-4062
	N	3190	2524	36	- 630	-2858	3660	2524	36	-1100	-5162
	D	3160	3036	36	- 88	-2946	3620	3396	36	- 188	-5350
1955	J	2810	3990	36	+1216	-1730	3220	4630	36	+1446	-3904
	F	2920	3345	36	+ 461	-1269	3340	3835	36	+ 531	-3373
	M	2960	3863	36	+ 939	- 330	3400	4298	36	+ 934	-2439
	A	3980	3709	–	+ 330	full	3410	4295	36	+ 921	-1518
	M	3100	3983	–	–	full	3550	4003	36	+ 489	-1029
	J	3120	3150	–	–	full	3580	3150	36	- 394	-1423
	J	3200	3053	36	- 111	- 111	3680	3053	36	- 591	-2014
	A	3280	2600	36	- 644	- 755	3760	2600	36	-1124	-3138
	S	3260	2569	36	- 655	-1410	3730	2569	36	-1125	-4263
	O	3240	2373	36	- 831	-2241	3710	2373	36	-1301	-5564
	N	3190	3265	36	+ 111	-2130	3660	3295	36	- 329	-5893
	D	3160	3529	36	+ 405	-2535	3620	4129	36	+ 545	-5348
Sum total	(7)			324					432		

Col.(1). The period shown in the Table is the most critical period on record.
Col.(2) lists the required energy in the load year stated above, in MWmonth.
Col.(3) lists the available energy from the hydro plants on that corresponding load year with no regulation from storage reservoirs.
Col.(4) lists the thermal energy production, in MWmonth.
Col.(5) shows the difference between Cols. (3)+(4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6) shows the deficiency in the storage reservoir, in MWmonth.
Row (7) Sum total of Col. (4) correspondent to the year 1955.

Table nº 3.8. Thermal Energy Requirements for Sequence B, for Dry Period Conditions

... Cont. 5.

Year (1)	Month	1982 Req. Energy (2)	Avail. Hydro. (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1983 Req. Energy (2)	Avail. Hydro. (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1954	M	4030	4982	-	-	-	4550	5622	-	-	-
	J	4070	4137	-	-	-	4600	4777	-	-	-
	J	4170	3230	576	- 364	- 364	4720	3870	576	- 274	- 274
	A	4260	2639	576	-1045	-1409	4830	3279	576	- 975	-1249
	S	4230	2308	576	-1346	-2755	4790	2948	576	-1266	-2515
	O	4210	2497	576	-1137	-3892	4760	3137	576	-1047	-3562
	N	4150	2524	576	-1050	-4942	4690	3164	576	- 950	-4512
	D	4110	3396	576	- 138	-5080	4650	4036	576	-538	-5050
1955	J	3660	4660	576	+1576	-3504	4150	5300	576	+1726	-3324
	F	3780	3835	576	+ 631	-2873	4290	4475	576	+ 761	-2563
	M	3850	4298	576	+1024	-1849	4360	4938	576	+1154	-1409
	A	3870	4295	576	+1001	- 848	4380	4935	576	+ 631	- 778
	M	4030	4003	576	+ 549	- 299	4550	4643	576	+ 669	- 109
	J	4070	3150	576	- 344	- 643	4600	3790	576	- 234	- 343
	J	4170	3053	576	- 541	-1184	4720	3693	576	- 451	- 794
	A	4260	2600	576	-1084	-2268	4830	3240	576	-1014	-1808
	S	4230	2569	576	-1085	-3353	4790	3209	576	-1005	-2813
	O	4210	2373	576	-1261	-4614	4760	3013	576	-1171	-3984
	N	4150	3295	576	- 279	-4893	4690	3935	576	- 179	-4163
	D	4110	4129	576	+ 595	-4278	4640	4769	576	+ 705	-3458
Sum total (7)				6,912					6,912		

Col.(1). The period shown in the Table is the most critical period on record.
Col.(2) lists the required energy in the load year stated above, in MWmonth.
Col.(3) lists the available energy from the hydro plants on that corresponding load year with no regulation from storage reservoirs.
Col.(4) lists the thermal energy production, in MWmonth.
Col.(5) shows the difference between Cols. (3)+(4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6) shows the deficiency in the storage reservoir, in MWmonth.
Row (7) Sum total of Col. (4) correspondent to the year 1955.

Table nº 3.8. Thermal Energy Requirements for Sequence B, for Dry Period Conditions

... Cont. 6.

Year (1)	Month	1984 Req. Energy (2)	Avail. Hydro. (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1985 Req. Energy (2)	Avail. Hydro. (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1954	M	5130	6262	-	-	-	5700	6902	-	-	-
	J	5180	5417	-	-	-	5750	6057	-	-	-
	J	5320	4180	576	- 564	- 564	5900	4180	576	- 144	- 144
	A	5430	3719	576	-1135	-1699	6040	3719	576	-1745	-1889
	S	5400	3263	576	-1561	-3260	5980	3263	675	-2141	-4030
	O	5370	3537	576	-1257	-4517	5950	3537	576	-1837	-5867
	N	5280	3574	576	-1130	-5647	5860	3574	576	-1710	-7577
	D	5240	4676	576	+ 12	-5635	5810	4746	576	- 488	-8065
1955	J	4670	5940	576	+1846	3789	5180	6580	576	+1976	-6089
	F	4840	5115	576	+ 851	-2938	5360	5725	576	+ 941	-5148
	M	4910	5578	576	+1244	-1694	5450	6168	576	+1294	-3854
	A	4930	6575	49	+1694	full	5470	6215	576	+1321	-2533
	M	5130	5283	-	-	full	5700	5313	576	+ 189	-2344
	J	5180	4430	576	- 174	- 174	5750	5040	576	- 134	-2478
	J	5320	4333	576	- 411	- 585	5900	4743	576	- 581	-3059
	A	5430	3705	576	-1149	-1734	6040	3705	576	-1759	-4818
	S	5400	3794	576	-1030	-2764	5980	3794	576	-610	-6428
	O	5370	3303	576	-1491	-4255	5950	3303	576	-2071	-8499
	N	5280	4575	576	- 129	-4384	5860	4760	576	- 524	-9023
	D	5240	5409	576	+ 745	-3639	5810	5929	576	+ 695	-8328
Sum total (7)				5,809					6,912		

Col.(1). The period shown in the Table is the most critical period on record.
Col.(2) lists the required energy in the load year stated above, in MWmonth.
Col.(3) lists the available energy from the hydro plants on that corresponding load year with no regulation from storage reservoirs.
Col.(4) lists the thermal energy production, in MWmonth.
Col.(5) shows the difference between Cols. (3)+(4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6) shows the deficiency in the storage reservoir, in MWmonth.
Row (7) Sum total of Col. (4) correspondent to the year 1955.

Table nº 3.8. Thermal Energy Requirements for Sequence B, for Dry Period Conditions

.... Cont.7 .

Year (1)	Month	1986				
		Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1954	J	6440	6217	-	-	-
	J	6600	4180	1426	- 994	- 994
	A	6750	3719	1426	-1605	-2599
	S	6700	3263	1426	-2011	-4610
	O	6650	3537	1426	-1687	-6297
	N	6560	3574	1426	-1560	-7851
	D	6500	4746	1426	- 328	-8185
1955	J	5800	6630	1426	+2256	-5929
	F	6000	5725	1426	+1151	-4778
	M	6100	6168	1426	+1494	-3284
	A	6120	6275	1426	+1581	-1703
	M	6370	5313	1426	+ 369	-1334
	J	6440	5040	1426	+ 26	-1298
	J	6600	4743	1426	- 431	-1729
	A	6750	3705	1426	-1619	-3348
	S	6700	3794	1426	-1480	-4828
	O	6650	3303	1426	-1921	-6749
	N	6560	4760	1426	- 374	-7123
	D	6500	5929	1426	+ 855	-6268
Sum total (7)				17,112		

Note: In the following years of 1987, 1988, 1989 and 1990, Sequences A and B have the same composition and has already been computed in Table nº 3.7.

Table nº 3.10 Available Energy in the Average Year (1959) with no regulation from storage reservoirs

Year (1)	Month	JURUMIRIM Natural Flow (2)	JURUMIRIM Energy Prod (3)	PIRAJU Natural Flow (2)	PIRAJU Energy Prod (3)	XAVANTES Natural Flow (2)	XAVANTES Energy Prod (3)	SALTO GRANDE Natural Flow (2)	SALTO GRANDE Energy Prod (3)
1959	J	376	85	384	120	505	280	651	61
	F	358	85	365	120	538	298	744	61
	M	270	70	275	120	384	213	513	61
	A	248	64	253	116	358	199	481	61
	M	198	51	202	93	290	161	391	57
	J	160	41	163	75	237	131	321	47
	J	126	32	129	59	187	104	252	37
	A	152	39	155	71	218	121	290	42
	S	118	30	121	55	174	96	234	34
	O	126	32	129	59	189	105	256	37
	N	112	29	114	52	169	94	231	34
	D	140	36	143	66	204	113	274	40

Col.(1). The year 1959 represents the average year in the period of record (1932-1959). Average year is a year who has the same average of the whole period of record.
Col.(2). Lists the natural flow in cubic meter per second at the hydro sites.
Col.(3). Lists the energy production expressed in MWmonth.

Cont...

Table nº 3.10. Available Energy in the Average Year (1959) with no regulation from storage reservoirs

... Cont. 2.

Year	Month	CANOAS Natural Flow (2)	CANOAS Energy Prod (3)	CAPIVARA Natural Flow (2)	CAPIVARA Energy Prod (3)	TAQUARUÇU Natural Flow (2)	TAQUARUÇU Energy Prod (3)
(1)							
1959	J	855	238	1455	564	1512	320
	F	1019	260	1932	640	2007	330
	M	647	180	1065	412	1106	234
	A	563	157	905	350	940	199
	M	465	129	807	312	838	178
	J	374	104	635	246	660	140
	J	288	80	500	194	519	110
	A	350	97	576	223	597	126
	S	267	74	481	186	500	106
	O	296	82	524	202	545	115
	N	265	74	460	178	478	101
	D	311	86	483	187	502	106

Cont....

Table nº 3.10 Available Energy in the Average Year (1959) with no regulation from storage reservoirs

... Cont. 3.

Year	Month	BARRA BONITA		BARIRI		IBITINGA		PROMISSÃO	
		Natural Flow (2)	Energy Prod (3)	Natural Flow (2)	Energy Prod (3)	Natural Flow (2)	Energy Prod (3)	Natural Flow (2)	Energy Prod (3)
(1)									
1959	J	596	98	643	123	784	114	980	196
	F	450	74	502	96	658	114	877	175
	M	433	71	478	91	613	114	800	160
	A	410	67	453	86	582	111	760	152
	M	251	41	278	53	359	68	473	94
	J	208	34	229	44	292	56	379	76
	J	155	25	173	33	227	43	303	61
	A.	181	30	201	38	261	50	344	69
	S	137	22	152	29	197	37	258	51
	O	150	25	166	32	214	41	282	56
	N	183	30	194	37	227	43	273	54
	D	352	58	381	73	468	89	589	118

Cont...

Table nº 3.10. Available Energy in the Average Year (1959) with no regulation from storage reservoirs

... Cont. 4.

Year	Month	ÁGUA VERMELHA		ILHA SOLTEIRA		JUPIÃ		ILHA GRANDE	
		Natural Flow (2)	Energy Prod (3)	Natural Flow (2)	Energy Prod (3)	Natural Flow (2)	Energy Prod (3)	Natural Flow (2)	Energy Prod (3)
(1)									
1959	J	3409	1380	8826	3200	9214	1400	12350	3600
	F	2829	1290	7440	2720	7812	1400	14560	3840
	M	2665	1215	8979	3200	9317	1400	12050	3500
	A	2565	1170	6711	2460	7025	1370	11250	3270
	M	1625	740	4101	1500	4318	840	7110	2070
	J	1300	590	3351	1225	3553	692	5910	1720
	J	1222	555	2752	1005	2942	575	4490	1310
	A	1207	550	2523	925	2717	530	4490	1310
	S	1128	513	2165	793	2350	458	3710	1080
	O	1104	510	2231	816	2418	470	4190	1220
	N	1192	542	3304	1210	3480	678	5000	1455
	D	1399	636	4012	1470	4233	825	6990	2030

Cont....

Table nº 3.10. Available Energy in the Average Year (1959) with no regulation from storage reservoirs

... Cont. 5.

Year (1)	Month	JAGUARI Natural Flow (2)	JAGUARI Energy Prod (3)	GRAMINHA Natural Flow (2)	GRAMINHA Energy Prod (3)	EUCLIDES DA CUNHA AND LIMOEIRO Natural Flow (2)	EUCLIDES DA CUNHA AND LIMOEIRO Energy Prod (3)
1959	J		20	136	68	227	119
	F		20	82	60	139	119
	M		20	70	51.5	118	115
	A		20	36	26.5	95	92.5
	M		20	29	21	60	58
	J		20	29	21	48	47
	J		20	24	18	40	39
	A		20	22	16	39	38
	S		20	18	13	32	31
	O		20	19	14	32	31
	N		20	35	26	57	55
	D		20	47	35	77	75

Table nº 3.11 Thermal Energy Requirements for Sequence A, for Average Flow Conditions

Year (1)	Month	1971 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1972 Req. Energy (2)	Aval. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1959	J	700	1788	-	-	-	880	2168	-	-	-
	F	720	1729	-	-	-	910	2127	-	-	-
	M	735	1693	-	-	-	925	2006	-	-	-
	A	738	1658	-	-	-	930	1958	-	-	-
	M	767	1370	-	-	-	965	1370	-	-	-
	J	775	1133	-	-	-	980	1133	-	-	-
	J	795	926	-	-	-	1000	926	36	- 38	- 38
	A	813	824	-	-	-	1025	824	36	-165	-203
	S	806	770	36	-	-	1018	770	36	-212	-415
	O	802	806	-	-	-	1010	806	36	-168	-583
	N	790	1046	-	-	-	996	1046	36	+ 86	-497
	D	783	1364	-	-	-	986	1324	36	+414	- 83
Sum total (7)				36					216		

Col.(1). The year 1959 represents the average flow conditions.
Col.(2). lists the required energy in the load year stated above, in MWmonth.
Col.(3). lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.
Col.(4). lists the thermal energy production, in MWmonth.
Col.(5). shows the difference between cols.(3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6). shows the deficiency in the storage reservoir in MWmonth.

Row (7). Sum total of Col.(4).

Cont. ...

Table nº 3.11.Thermal Energy Requirements for Sequence A, for Average Flow Conditions

....Cont. 2.

Year (1)	Month	1973 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1974 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1959	J	1090	2168	-	-	-	1300	2848	-	-	-
	F	1130	2127	-	-	-	1350	2807	-	-	-
	M	1140	2006	-	-	-	1370	2686	-	-	-
	A	1150	1958	-	-	-	1380	2608	-	-	-
	M	1195	1370	-	-	-	1430	1850	-	-	-
	J	1210	1133	36	- 41	- 41	1450	1630	-	-	-
	J	1240	926	36	-258	- 299	1490	1406	36	- 48	- 48
	A	1270	824	36	-410	- 709	1520	1304	36	-180	-228
	S	1260	770	36	-454	-1163	1510	1250	36	-224	-452
	O	1250	806	36	-408	-1571	1500	1286	36	-178	-630
	N	1230	1046	36	-148	-1719	1480	1526	36	+ 82	-548
	D	1220	1364	36	+180	-1539	1460	1844	36	+420	-128
Sum total (7)				252					216		

Col.(1). The year 1959 represents the average flow conditions.

Col.(2). lists the required energy in the load year stated above, in MWmonth.

Col.(3). Lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.

Col.(4). lists the thermal energy production, in MWmonth.

Col.(5). shows the difference between cols. (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be sotred in the reservoir.

Col.(6). shows the deficiency in the storage reservoir in MWmonth.

Row (7). Sum total of Col.(4).

Cont. ...

Table nº 3.11 Thermal Energy Requirements for Sequence A, for Average Flow Conditions

.... Cont. 3.

Year (1)	Month	1975 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1976 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1959	J	1500	3328	-	-	-	1730	3808	-	-	-
	F	1560	3287	-	-	-	1790	3767	-	-	-
	M	1580	3166	-	-	-	1820	3646	-	-	-
	A	1590	3088	-	-	-	1830	3568	-	-	-
	M	1655	2330	-	-	-	1900	2810	-	-	-
	J	1670	2093	-	-	-	1920	2358	-	-	-
	J	1710	1886	-	-	-	1970	1931	36	- 3	- 3
	A	1750	1749	1	-	- 1	2020	1749	36	-235	-238
	S	1740	1563	36	-141	-142	2000	1563	36	-401	-639
	O	1730	1622	36	- 72	-214	1990	1622	36	-332	-971
	N	1700	2006	-	+214	full	1960	2256	36	+332	-639
	D	1690	2324	-	-	-	1940	2804	-	+639	full
Sum total (7)				73					180		

Col.(1). The year 1959 represents the average flow conditions.
Col.(2). lists the required energy in the load year stated above, in MWmonth.
Col.(3). lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.
Col.(4). lists the thermal energy production, in MWmonth.
Col.(5). shows the difference between cols. (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6). shows the deficiency in the storage reservoir in MWmonth.

Row (7). Sum total of Col.(4)

Cont. ...

Table nº 3.11. Thermal Energy Requirements for Sequence A, for Average Flow Conditions

.... Cont. 4.

Year (1)	Month	1977 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1978 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Ator. (6)
1959	J	1990	4448	-	-	-	2260	4888	-	-	-
	F	2060	4047	-	-	-	2340	4902	-	-	-
	M	2090	4286	-	-	-	2370	4538	-	-	-
	A	2100	4208	-	-	-	2380	4390	-	-	-
	M	2180	3182	-	-	-	2480	3276	-	-	-
	J	2210	2604	-	-	-	2510	2680	-	-	-
	J	2260	2125	36	- 99	- 99	2570	2186	36	-348	- 348
	A	2310	1972	36	-302	- 401	2630	2041	36	-553	- 901
	S	2300	1749	36	-515	- 916	2610	1800	36	-774	-1675
	O	2280	1824	36	-420	-1336	2600	1880	36	-684	-2359
	N	2250	2434	36	+220	-1116	2560	2488	36	- 36	-2395
	D	2230	3021	36	+827	- 289	2530	3139	36	+ 36	-1750
Sum total (7)				216					216		

Col.(1). The year 1959 represents the average flow conditions.
Col.(2). lists the required energy in the load year stated above, in MWmonth.
Col.(3). lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.
Col.(4). lists the thermal energy production, in MWmonth.
Col.(5). shows the difference between cols. (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6). shows the deficiency in the storage reservoir in MWmonth.

Row (7). Sum total of Col.(4).

Cont. ...

Table nº 3.11. Thermal Energy Requirements for Sequence A, for Average Flow Conditions

....Cont. 5.

Year (1)	Month	1979 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1980 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1959	J	2560	4888	-	-	-	2810	5208	-	-	-
	F	2650	4902	-	-	-	2920	5222	-	-	-
	M	2690	4538	-	-	-	2960	4858	-	-	-
	A	2900	4390	-	-	-	2980	4710	-	-	-
	M	2810	3276	-	-	-	3100	3276	-	-	-
	J	2820	2680	36	- 104	- 104	3120	2680	440	-	-
	J	2910	2186	36	- 688	- 792	3200	2186	576	-438	- 438
	A	2980	2041	36	- 903	-1695	3280	2041	576	-663	-1101
	S	2960	1800	36	-1124	-2819	3260	1800	576	-984	-1985
	O	2950	1880	36	-1034	-3853	3240	1880	576	-784	-2769
	N	2900	2488	36	- 376	-4229	3190	2488	576	-126	-2895
	D	2870	3139	36	+ 305	-3924	3160	3139	576	+555	-2340
Sum.total..(7)				252					3,896		

Col.(1). The year 1959 represents the average flow conditions.
Col.(2). lists the required energy in the load year stated above, in MWmonth.
Col.(3). lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.
Col.(4). lists the thermal energy production, in MWmonth.
Col.(5). shows the difference between cols. (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6). shows the deficiency in the storage reservoir in MWmonth.

Row (7). Sum total of Col.(4).

Cont. ...

Table nº 3.11. Thermal Energy Requirements for Sequence A, for Average Flow Conditions

... Cont. 6.

Year (1)	Month	1981 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1982 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1959	J	3220	5898	-	-	-	3660	6826	-	-	-
	F	3340	5912	-	-	-	3780	6862	-	-	-
	M	3400	5548	-	-	-	3850	6402	-	-	-
	A	3410	5400	-	-	-	3870	6192	-	-	-
	M	3550	3966	-	-	-	4030	4366	-	-	-
	J	3580	3270	310	-	-	4070	3589	481	-	-
	J	3680	2741	576	-363	- 363	4170	2990	576	- 604	- 604
	A	3760	2591	576	-593	- 956	4260	2885	576	- 799	-1403
	S	3730	2313	576	-841	-1797	4230	2548	576	-1106	-2509
	O	3710	2390	576	-744	-2541	4210	2646	576	- 988	-3497
	N	3660	3030	576	- 54	-2595	4150	3257	576	- 817	-4314
	D	3620	3775	576	+731	-1864	4110	4033	576	+ 499	-3815
Sum.total (7)				3,766					3,937		

Col.(1). The year 1959 represents the average flow conditions.
Col.(2). lists the required energy in the load year stated above, in MWmonth.
Col.(3). lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.
Col.(4). lists the thermal energy production, in MWmonth.
Col.(5). shows the difference between cols. (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6). shows the deficiency in the storage reservoir in MWmonth.

Row (7). Sum total of Col.(4).

Cont. ...

Table nº 3.11 Thermal Energy Requirements for Sequence A, for Average Flow Conditions

...Cont. 7.

Year (1)	Month	1983 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1984 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1959	J	4150	7786	-	-	-	4670	8886	-	-	-
	F	4290	7822	-	-	-	4840	8612	-	-	-
	M	4360	7362	-	-	-	4910	8392	-	-	-
	A	4380	6892	-	-	-	4930	7602	-	-	-
	M	4550	5006	-	-	-	5130	5536	-	-	-
	J	4600	4229	371	-	-	5180	4709	471	-	-
	J	4720	3630	576	- 514	- 514	5320	4110	576	- 634	- 634
	A	4830	3525	576	- 729	-1243	5430	4005	576	- 649	-1283
	S	4790	3188	576	-1026	-2269	5400	3668	576	-1156	-2439
	O	4760	3286	576	- 898	-3167	5370	3766	576	-1028	-3467
	N	4690	3897	576	- 218	-3384	5280	4377	576	- 327	-3794
	D	4650	4673	576	+ 599	-2785	5240	5153	576	- 489	-4283
Sum total	(7)			3,827					3,927		

Col.(1). The year 1959 represents the average flow conditions.
Col.(2). lists the required energy in the load year stated above, in MWmonth.
Col.(3). lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.
Col.(4). lists the thermal energy production, in MWmonth.
Col.(5). shows the difference between cols. (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6). shows the deficiency in the storage reservoir in MWMonth.

Row (7). Sum total of Col.(4).

Cont. ...

Table nº3.11.Thermal Energy Requirements for Sequence A, for Average Flow Conditions

....Cont..8.

Year (1)	Month	1985 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1986 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1959	J	5180	9986	-	-	-	5800	10306	-	-	-
	F	5360	9462	-	-	-	6000	9782	-	-	-
	M	5450	9327	-	-	-	6100	9647	-	-	-
	A	5470	8332	-	-	-	6120	8652	-	-	-
	M	5700	6016	-	-	-	6370	6036	1334	-	-
	J	5750	5189	561	-	-	6440	5309	1136	-	-
	J	5900	4300	576	-1024	-1024	6600	4300	1426	- 874	-874
	A	6040	4195	576	-1269	-2293	6750	4195	1426	-1129	-2003
	S	5980	3668	576	-1936	-4029	6700	3668	1426	-1606	-3609
	O	5950	3866	576	-1508	-5537	6650	3866	1426	-1358	-4967
	N	5860	4712	576	- 572	-6109	6560	4712	1426	- 422	-5389
	D	5810	5633	576	+ 399	-5710	6500	5953	1426	+ 879	-4510
Sum total	(7)			4,017					10021		

Col.(1). The year 1959 represents the average flow conditions.

Col.(2). lists the required energy in the load year stated above, in MWmonth.

Col.(3). lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.

Col.(4). lists the thermal energy production, in MWmonth.

Col.(5). shows the difference between cols. (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.

Col.(6). shows the deficiency in the storage reservoir in MWmonth.

Row (7). Sum total of Col.(4).

Cont. ...

Table nº3.11.Thermal Energy Requirements for Sequence A, for Average Flow Conditions

....Cont..9.

Year (1)	Month	1987 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1988 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1959	J	6450	10626	-	-	-	7160	11106	-	-	-
	F	6680	10102	-	-	-	7420	10582	-	-	-
	M	6780	9967	-	-	-	9550	10447	-	-	-
	A	6820	8972	-	-	-	7590	9452	-	-	-
	M	7100	6186	914	-	-	9880	6186	1694	-	-
	J	7160	5309	1851	-	-	7960	5309	2651	-	-
	J	7350	4300	2276	- 774	- 774	8160	4300	3126	- 734	- 734
	A	7510	4195	2276	-1039	-1813	8350	4195	3126	-1029	-1763
	S	7450	3668	2276	-1506	-3319	8290	3668	3126	-1496	-3259
	O	7420	3866	2276	-1278	-4597	8250	3866	3126	-1258	-4517
	N	7300	4712	2276	- 312	-4909	8120	4712	3126	- 282	-4799
	D	7250	6063	2276	+1089	-3820	8050	6063	3126	+1139	-3660
Sum.Total (7)				16421					23,101		

Col.(1). The year 1959 represents the average flow conditions.

Col.(2). lists the required energy in the load year stated above, in MWmonth.

Col.(3). lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.

Col.(4). lists the thermal energy production, in MWmonth.

Col.(5). shows the difference between cols. (3+4) and (2).. Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.

Col.(6). shows the deficiency in the storage reservoir in MWmonth.

Row (7). Sum total of Col.(4).

Cont. ...

Table n93.11 Thermal Energy Requirements for Sequence A, for Average Flow Conditions

... Cont. 10 .

Year (1)	Month	1989 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1990 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1959	J	7960	11106	-	-	-	8800	11106	-	-	-
	F	8240	10582	-	-	-	9120	10582	-	-	-
	M	8370	10447	-	-	-	9260	10447	-	-	-
	A	8420	9452	-	-	-	9310	9452	-	-	-
	M	8750	6186	2564	-	-	9700	6186	3514	-	-
	J	8850	5309	3541	-	-	9800	5309	4491	-	-
	J	9070	4300	3976	- 794	- 794	10050	4300	5126	- 24	- 24
	A	9270	4195	3976	-1099	-1893	10250	4195	5726	- 329	- 353
	S	9200	3668	3976	-1556	-3449	10190	3668	5726	- 796	-1149
	O	9150	3866	3976	-1308	-4757	10120	3866	5726	- 528	-1677
	N	9020	4712	3976	- 332	-5089	9960	4712	5726	-478	-2155
	D	8940	6063	3976	-1099	-6188	9880	6063	5726	+1909	- 246
Sum total (7)				29,961					42,361		

Col.(1). The year 1959 represents the average flow conditions.
Col.(2). lists the required energy in the load year stated above, in MWmonth.
Col.(3). lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.
Col.(4). lists the thermal energy production, in MWmonth.
Col.(5). shows the difference between cols. (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6). shows the deficiency in the storage reservoir in MWmonth.
Row (7). Sum total of Col.(4).

Table nº 3.12 Thermal Energy Requirements for Sequence B, for Average Flow Conditions

Year (1)	Month	1971 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1972 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1959	J	700	1788	-	-	-	880	2168	-	-	-
	F	720	1729	-	-	-	910	2127	-	-	-
	M	735	1693	-	-	-	925	2006	-	-	-
	A	738	1658	-	-	-	930	1958	-	-	-
	M	767	1370	-	-	-	965	1370	-	-	-
	J	775	1133	-	-	-	980	1133	-	-	-
	J	795	926	-	-	-	1000	926	36	- 38	- 38
	A	813	824	-	-	-	1025	824	36	-165	-203
	S	806	770	36	-	-	1018	770	36	- 12	-415
	O	802	806	-	-	-	1010	806	36	-168	-583
	N	790	1046	-	-	-	996	1046	36	+ 86	-497
	D	783	1364	-	-	-	986	1364	36	+414	-83
Sum total (7)				36					216		

Col.(1). The year 1959 represents the average flow conditions.
Col.(2). lists the required energy in the load year stated above, in MWmonth.
Col.(3). lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.
Col.(4). lists the thermal energy production, in MWmonth.
Col.(5). shows the difference between cols. (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6). shows the deficiency in the storage reservoir in MWmonth.

Row (7). Sum total of Col.(4).

Cont. ...

Table nº 3.12 Thermal Energy Requirements for Sequence B, for Average Flow Conditons

.... Cont. 2.

Year (1)	Month	1973 Req. Energy (2)	1973 Avail. Hydro (3)	1973 Ther. (4)	1973 Draw (5)	1973 Acc. Stor. (6)	1974 Req. Energy (2)	1974 Avail. Hydro (3)	1974 Ther. (4)	1974 Draw (5)	1974 Acc. Stor. (6)
1959	J	1090	2168	-	-	-	1300	2488	-	-	-
	F	1130	2127	-	-	-	1350	2447	-	-	-
	M	1140	2006	-	-	-	1370	2386	-	-	-
	A	1150	1958	-	-	-	1380	2278	-	-	-
	M	1195	1370	-	-	-	1430	1682	-	-	-
	J	1210	1133	36	- 41	- 41	1450	1379	36	- 35	- 35
	J	1240	926	36	-278	-319	1490	1120	36	-334	- 369
	A	1270	824	36	-410	-729	1520	1047	36	-437	- 806
	S	1260	770	36	-454	-1183	1510	956	36	-618	-1424
	O	1250	806	36	-408	-1591	1500	1008	36	-456	-1880
	N	1230	1046	36	-148	-1739	1480	1124	36	-320	-2200
	D	1220	1364	36	+180	-1559	1460	1551	36	+127	-2073
Sum total (7)				252					252		

Col.(1). The Year 1959 represents the average flow conditions.

Col.(2). lists the required energy in the load year stated above, in MWmonth.

Col.(3). lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.

Col.(4). lists the thermal energy production, in MWmonth.

Col.(5). shows the difference between cols. (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.

Col.(6). shows the deficiency in the storage reservoir in MWmonth.

Row (7). Sum total of Col.(4).

Cont ...

Table nº 3.12 Thermal Energy Requirements for Sequence B, for Average Flow Conditions

... Cont. 3.

Year (1)	Month	1975 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1976 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1959	J	1500	2878	-	-	-	1730	3307	-	-	-
	F	1560	2837	-	-	-	1790	3342	-	-	-
	M	1580	2708	-	-	-	1820	3053	-	-	-
	A	1590	2538	-	-	-	1830	2883	-	-	-
	M	1655	1912	-	-	-	1900	2257	-	-	-
	J	1670	1609	36	- 25	- 25	1920	1954	-	-	-
	J	1710	1350	36	-324	- 349	1970	1675	36	-259	- 259
	A	1750	1277	36	-437	- 786	2020	1597	36	-387	- 646
	S	1740	1186	36	-518	-1304	2000	1469	36	-495	-1141
	O	1730	1238	36	-456	-1760	1990	1518	36	-436	-1577
	N	1700	1354	36	-310	-2070	1960	1666	36	-258	-1835
	D	1690	1781	36	+127	-1943	1940	2126	36	+222	-1613
Sum total	(7)			252					216		

Col.(1). The year 1959 represents the average flow conditions.

Col.(2). lists the required energy in the load year stated above, in MWmonth.

Col.(3). lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.

Col.(4). lists the thermal energy production, in MWmonth.

Col.(5). shows the difference between cols. (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.

Col.(6). shows the deficiency in the storage reservoir in MWmonth.

Row (7). Sum total of Col.(4).

Cont. ...

Table nº 3.12 Thermal Energy Requirements for Sequence B, for Average Flow Conditions

....Cont. 4.

Year (1)	Month	1977 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1978 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1959	J	1990	3827	-	-	-	2260	4285	-	-	-
	F	2060	3862	-	-	-	2340	4342	-	-	-
	M	2090	3573	-	-	-	2370	3957	-	-	-
	A	2100	3386	-	-	-	2380	3725	-	-	-
	M	2180	2654	-	-	-	2480	2926	-	-	-
	J	2210	2148	36	- 66	- 66	2510	2364	36	-110	- 110
	J	2260	1814	36	-410	- 476	2570	1985	36	-549	- 659
	A	2310	1765	36	-509	- 985	2630	1960	36	-634	-1293
	S	2300	1598	36	-666	-1651	2610	1755	36	-819	-2112
	O	2280	1659	36	-585	-2236	2600	1830	36	-734	-2846
	N	2250	1792	36	-422	-2658	2560	1947	36	-577	-3423
	D	2230	2278	36	+ 84	-2534	2530	2502	36	+ 8	
Sum total (7)				252					252		

Col.(1). The year 1959 represents the average flow conditions.

Col.(2). lists the required energy in the load year stated above, in MWmonth.

Col.(3). lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.

Col.(4). lists the thermal energy production, in MWmonth.

Col.(5). shows the difference between cols. (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.

Col.(6). shows the deficiency in the storage reservoir in MWmonth.

Row (7). Sum total of Col.(4).

Cont. ...

Table nº 3.12 Thermal Energy Requirements for Sequence B, for Average Flow Conditions

....Cont..5.

Year (1)	Month	1979 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1980 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1959	J	2560	4931	-	-	-	2810	5801	-	-	-
	F	2650	4977	-	-	-	2920	5847	-	-	-
	M	2690	4497	-	-	-	2960	5367	-	-	-
	A	2700	4227	-	-	-	2980	5097	-	-	-
	M	2810	3246	-	-	-	3100	3886	-	-	-
	J	2820	2684	36	-100	- 100	3120	3324	-	-	-
	J	2910	2305	36	-569	- 669	3200	2945	36	-219	- 219
	A	2980	2280	36	-664	-1333	3280	2885	36	-359	- 578
	S	2960	2075	36	-849	-2182	3260	2548	36	-636	-1214
	O	2950	2150	36	-764	-2946	3240	2646	36	-558	-1772
	N	2900	2267	36	-597	-3543	3190	2907	36	-247	-2019
	D	2870	2822	36	- 12	-3555	3160	3462	36	+338	-1681
Sum total	(7)			252					216		

Col.(1). The year 1959 represents the average flow conditions.
Col.(2). lists the required energy in the load year stated above, in MWmonth.
Col.(3). lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.
Col.(4). lists the thermal energy production, in MWmonth.
Col.(5). shows the difference between cols. (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6). shows the deficiency in the storage reservoir in MWmonth.
Row. (7). Sum total of Col.(4).

Cont. ...

Table nº 3.12 Thermal Energy Requirements for Sequence B, for Average Flow Conditions

....Cont. 6.

Year (1)	Month	1981 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1982 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1959	J	3220	6556	-	-	-	3660	6946	-	-	-
	F	3340	6602	-	-	-	3780	6902	-	-	-
	M	3400	6122	-	-	-	3850	6347	-	-	-
	A	3410	5852	-	-	-	3870	6032	-	-	-
	M	3550	4426	-	-	-	4030	4426	-	-	-
	J	3580	3689	-	-	-	4070	3689	381	-	-
	J	3680	2990	36	- 654	- 654	4170	2990	576	- 604	- 604
	A	3760	2885	36	- 839	-1493	4260	2885	576	- 799	-1403
	S	3730	2540	36	-1146	-2639	4230	2548	576	-1106	-2509
	O	3710	2646	36	-1028	-3667	4210	2646	576	- 988	-3497
	N	3660	3157	36	- 467	-4134	4150	3157	576	- 417	-3914
	D	3620	3972	36	+ 388	-3746	4110	3972	576	+ 438	-3476
Sum total (7)				216					3,837		

Col.(1). The year 1959 represents the average flow conditions.
Col.(2). lists the required energy in the load year stated above, in MWmonth.
Col.(3). lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.
Col.(4). lists the thermal energy production, in MWmonth.
Col.(5). shows the difference between cols. (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.
Col.(6). shows the deficiency in the storage reservoir in MWmonth.

Row (7). Sum total of col.(4).

Cont. ...

Table nº 3.12. Thermal Energy Requirements for Sequence B, for Average Flow Conditions

....Cont..7.

Year (1)	Month	1983 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1984 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1959	J	4150	7906	-	-	-	4670	9026	-	-	-
	F	4290	7862	-	-	-	4840	8982	-	-	-
	M	4360	7307	-	-	-	4910	8427	-	-	-
	A	4380	6992	-	-	-	4930	8012	-	-	-
	M	4550	5066	-	-	-	5130	5706	-	-	-
	J	4600	4329	271	-	-	5180	4969	211	-	-
	J	4720	3630	576	- 514	- 514	5320	4270	576	- 474	-476
	A	4830	3525	576	- 729	-1243	5430	4165	576	- 689	-1165
	S	4790	3188	576	-1026	-2269	5400	3628	576	-1196	-2361
	O	4760	3286	576	- 798	-3067	5370	3866	576	- 928	-3289
	N	4690	3797	576	- 317	-3384	5280	4437	576	- 267	-3556
	D	4650	4612	576	+ 538	-2846	5240	5252	576	+ 588	-2968
Sum total	(7)			3,727					3,667		

Col.(1). The year 1959 represents the average flow conditions.

Col.(2). lists the required energy in the load year stated above, in MWmonth.

Col.(3). lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.

Col.(4). lists the thermal energy production, in MWmonth.

Col.(5). shows the difference between cols. (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.

Col.(6). shows the deficiency in the storage reservoir in MWmonth.

Row (7). Sum total of Col.(4).

Cont. ...

Table nº 3.12.Thermal Energy Requirements for Sequence B, for Average Flow Conditions

... Cont. 8.

Year (1)	Month	1985 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)	1986 Req. Energy (2)	Avail. Hydro (3)	Ther. (4)	Draw (5)	Acc. Stor. (6)
1959	J	5180	9986	-	-	-	5800	10306	-	-	-
	F	5360	9782	-	-	-	6000	9942	-	-	-
	M	5450	9087	-	-	-	6100	9407	-	-	-
	A	5470	8652	-	-	-	6120	8812	-	-	-
	M	5700	6346	-	-	-	6370	6496	-	-	-
	J	5750	5409	341	-	-	6440	5409	1031	-	-
	J	5900	4300	576	-1024	-1024	6600	4300	1426	- 974	- 974
	A	6040	4195	576	-1269	-2293	6950	4195	1426	-1129	-2103
	S	5980	3628	576	-1776	-4069	6700	3628	1426	-1646	-3749
	O	5950	3866	576	-1508	-5577	6650	3866	1426	-1358	-5107
	N	5860	4612	576	- 672	-6249	6560	4612	1426	- 522	-5629
	D	5810	5892	576	+ 658	-5591	6500	6002	1426	- 928	-4701
Sum total (7)				3,797					9,587		

Col.(1). The year 1959 represents the average flow conditions.

Col.(2). lists the required energy in the load year stated above, in MWmonth.

Col.(3). lists the available energy from the hydro plants on that corresponding load year with no reservoir regulation, in MWmonth.

Col.(4). lists the thermal energy production, in MWmonth.

Col.(5). shows the difference between cols. (3+4) and (2). Negative signs indicate flow deficiency and therefore draw from storage. Plus signs indicate flow surplus which may be stored in the reservoir.

Col.(6). shows the deficiency in the storage reservoir in MWmonth.

Row (7). Sum total of Col.(4).

Note: In the following years of 1987, 88, 89 and 90, Sequences A and B have the same compositions and has already been computed in Table nº 3.11.

Table nº 3.13. Average Thermal Energy Requirements for Sequence A

Year (1)	Th. En. Req. Dry Year 1955 (2)		Th. En. Req. Average Year 1959 (3)		20% of Col. (2) (4)		80% of Col. (3) (5)		Average Thermal Energy Requirements (6)	
	oil	nuclear	oil	nuclear	oil	nuclear	oil	nuclear	oil	nuclear
1971	144	-	36	-	43	-	29	-	72	-
1972	288	-	216	-	43	-	173	-	216	-
1973	432	-	252	-	86	-	202	-	288	-
1974	288	-	216	-	58	-	173	-	231	-
1975	216	-	73	-	43	-	58	-	101	-
1976	288	-	180	-	58	-	144	-	202	-
1977	288	-	216	-	58	-	173	-	231	-
1978	360	-	216	-	72	-	173	-	245	-
1979	2376	-	252	-	474	-	202	-	676	-
1980	6844	-	3896	-	1370	-	3110	-	4480	-
1981	5797	-	3766	-	1160	-	3010	-	4170	-
1982	6912	-	3937	-	1380	-	3140	-	4520	-
1983	6112	-	3827	-	1220	-	3060	-	4280	-
1984	6912	-	3927	-	1380	-	3140	-	4520	-
1985	6912	-	4017	-	1380	-	3210	-	4590	-
1986	6912	10200	3737	6284	1380	2020	2980	5025	4360	7045
1987	6653	20400	3607	12814	1330	4080	2880	10250	4210	14330
1988	6912	27000	3857	17444	1380	5400	3080	13950	4460	19350
1989	6225	40800	3597	26364	1250	8160	2875	21000	4125	29160
1990	10560	48228	9097	33264	2110	9650	7260	26600	9370	36250

Col.(1) shows the period of study.

Col.(2) lists the thermal energy requirements in the Dry Year (1955) in MWmonth. The column is subdivided in two columns, the first one lists the energy produced by the oil fired plants and the second one lists the energy produced by the nuclear plants. This subdivision is necessary once the cost of fuel in each kind of station is different.

Col.(3) lists the thermal energy requirements in the Average year (1959) in MWmonth. The column is subdivided in two for the same purpose Col.(2) is.

Col.(6) lists the sum of Col.(4) and Col.(5) and represents the average thermal energy requirements, in MWmonth.

Table nº 3.14. Average Thermal Energy Requirements for Sequence B

Year (1)	Th. En. Req. Dry Year 1955 (2)		Th. En. Req. Average Year 1959 (3)		20% of Col.(2) (4)		80% of Col.(3) (5)		Average Thermal Energy Requirements (6)	
	oil	nuclear	oil	nuclear	oil	nuclear	oil	nuclear	oil	nuclear
1971	144	-	36	-	43	-	29	-	72	-
1972	288	-	216	-	43	-	173	-	216	-
1973	432	-	252	-	86	-	202	-	288	-
1974	427	-	252	-	85	-	202	-	287	-
1975	396	-	252	-	79	-	202	-	281	-
1976	360	-	216	-	72	-	173	-	245	-
1977	432	-	252	-	86	-	202	-	288	-
1978	432	-	252	-	86	-	202	-	288	-
1979	432	-	252	-	86	-	202	-	288	-
1980	324	-	216	-	65	-	173	-	238	-
1981	432	-	216	-	86	-	173	-	259	-
1982	6912	-	3837	-	1380	-	3060	-	4440	-
1983	6912	-	3727	-	1380	-	2980	-	4360	-
1984	5809	-	3667	-	1162	-	2930	-	4092	-
1985	6912	-	3797	-	1380	-	3040	-	4420	-
1986	6912	10200	3637	5950	1380	2040	2900	4760	6140	8180
1987	6653	20400	3607	12814	1330	4080	2880	10250	4210	14330
1988	6912	27000	3857	17444	1380	5400	3080	13950	4460	19350
1989	6225	40800	3597	26364	1250	8160	2875	21000	4125	29160
1990	10560	48228	9097	33264	2110	9650	7260	26600	9370	36250

Col.(1) shows the period of study.

Col.(2) lists the thermal energy requirements in the Dry year (1955) in MWmonth. The column is subdivided in two columns, the first one lists the energy produced by the oil fired plants and the second one lists the energy produced by the nuclear plants. This subdivitions is necessary once the cost of fuel in each kind of station is different.

Col.(3) lists the thermal energy requirements in the Average Year (1959) in MWmonth. The column is sub - divided in two for the same purpose Col.(2) is.

Col.(6) Lists the sum of Col.(4) and Col.(5) and represents the average thermal energy requirement$, in MWmonth.

Table nº 3.15. Variable Annual Charges of Thermal Additions in Sequence A

Year (1)	Aver. Ther. Energy Req. Oil Thermal Additions (2)	Aver. Ther. Energy Req. Nuclear Th. Additions (3)	Variable Charges of Oil Thermal Additions (4)	Variable Charges of Nuclear Ther. Additions (5)	Variable Charges of Thermal Additions (6)
1971	772	-	205	-	205
1972	216	-	644	-	644
1973	288	-	850	-	850
1974	231	-	673	-	673
1975	101	-	292	-	292
1976	202	-	585	-	585
1977	231	-	673	-	673
1978	245	-	732	-	732
1979	676	-	1990	-	1990
1980	4480	-	13100	-	13100
1981	4190	-	12200	-	12200
1982	4520	-	13200	-	13200
1983	4280	-	12530	-	12530
1984	4520	-	13200	-	13200
1985	4590	-	13400	-	13400
1986	4360	7045	12780	7740	20520
1987	4210	14330	12300	15750	28050
1988	4460	19350	13060	21300	34360
1989	4125	29160	12080	32000	44080
1990	9370	36250	27400	39800	67200

Col.(1) Shows the period of study.
Col.(2) lists the average thermal energy requirements in MWmonth from the oil fired thermal stations.
Col.(3) lists the average thermal energy requirements in MWmonth from the nuclear thermal stations.
Col.(4) lists the variable charges of the oil fired thermal additions in millions of US$.
Col.(5) lists the variable charges of the nuclear thermal additions in millions of US$.
Col.(6) lists the sum of Cols.(4) and (5) and represents the variable charges of all thermal additions in millions of US$.

Note: The computations done in this Table are explained in page (28) of the text.

Table nº 3.16. Variable Annual Charges of Thermal Additions in Sequence B

Year (1)	Aver. Ther. Energy Req. Oil Thermal Additions (2)	Aver. Ther. Energy Req. Nuclear Th. Additions (3)	Variable Charges of Oil Thermal Additions (4)	Variable Charges of Nuclear Ther. Additions (5)	Variable Charges of Thermal Additions (6)
1971	72	-	205	-	205
1972	216	-	644	-	644
1973	288	-	850	-	850
1974	287	-	850	-	850
1975	281	-	820	-	820
1976	245	-	732	-	732
1977	288	-	850	-	850
1978	288	-	850	-	850
1979	288	-	850	-	850
1980	238	-	702	-	702
1981	259	-	760	-	760
1982	4440	-	13000	-	13000
1983	4360	-	12780	-	12780
1984	4092	-	11960	-	11960
1985	4420	-	12920	-	12920
1986	6140	8180	17950	9000	26950
1987	4210	14330	12300	15750	28050
1988	4460	19350	13060	21300	34360
1989	4125	29160	12080	32000	44080
1990	9370	36250	27400	39800	67200

Col.(1) Shows the period of study.
Col.(2) Lists the average thermal energy requirements in MWmonth from the oil fired thermal stations.
Col.(3) Lists the average thermal energy requirements in MWmonth from the nuclear thermal stations.
Col.(4) Lists the variable charges of the oil fired thermal additions in millions of US$.
Col.(5) Lists the variable charges of the nuclear thermal additions in millions of US$.
Col.(6) Lists the sum of Cols.(4) and (5) and represents the variable charges of all thermal additions in millions of US$.

Table nº 3.17. Hydro Plants: Final Installed Capacity, Number of Units, Total Cost, Transmission Costs

Name (1)	Installed Capacity (2)	Number of Units (3)	Total Cost (4)	80% of Col. (4) (5)	20% of Col. (4) (6)	Cost per Unit (7)	Transmission Costs (8)
Ilha Solteira	3200	20, 160	627	500	127	6.35	67
Capivara	640	4, 160	155	124	31	7.75	60
Água Vermelha	1380	12, 115	244	195	49	4.1	70
Promissão	210	3, 70	130	104	26	8.7	12
Taquaruçu	330	4, 83	70	56	14	3.5	60
Canoas	250	3 85	69	55	14	4.7	24
Piraju	120	2, 60	39	31	8	4,0	20
Ilha Grande	3840	24, 160	660	530	130	5.4	70

Col.(1). lists the names of the hydro plants.
Col.(2). shows the final installed capacity at each plant in MW.
Col.(3). the first figure indicates the number of units and the second figure indicates the capacity of each unit in MW.
Col.(4). shows the total cost, in millions of US$, of each plant at the final installed capacity. This cost is subdivided in two in Cols.(5) and (6). It does not include transmission costs.
Col.(5). was calculated as 80 per cent of the total cost and represents the cost of the dam and related works.
Col.(6). was calculated as 20 percent of the total cost and represents the cost of the turbines and generators
Col.(7). was obtained by the division of the cost of Col.(6) by the number of units of Col.(3). This cost, also in millions of US$, represents the cost per unit of turbine and generator.
Col.(8). costs of transmission, in dollars per kW of installed capacity, taken from Table nº 454-1, page 4-65 of "Power Study of South Central Brasil", CANAMBRA, vol. 1, December 1966.

Table nº 3.18. Computation of the Annual Charges of Hydro Additions in Sequence A

Year (1)	Ilha Solt. (2)	Capi. (3)	Prom. (4)	Água Verm. (5)	Taqua. (6)	Canoas (7)	Pirajú (8)	Ilha Grande (9)	Trans. Costs (10)	Total Costs (11)	Annual ch. of hydro (9%) (12)
1971	–	–	–	–	–	–	–	–	–	–	–
1972	–	–	–	–	–	–	–	–	–	–	–
1973	519.0	–	–	–	–	–	–	–	214.0	733.0	66.0
1974	538.0	–	–	–	–	–	–	–	214.0	752.0	67.6
1975	557.0	–	–	–	–	–	–	–	214.0	771.0	69.4
1976	569.7	139.5	–	–	–	–	–	–	252.4	961.6	86.5
1977	569.7	155.0	130	–	–	–	–	–	254.9	1109.6	100.0
1978	569.7	155.0	130	–	–	–	–	–	254.9	1109.6	100.0
1979	582.4	155.0	130	–	–	–	–	–	254.9	1122.3	101.0
1980	582.4	155.0	130	219.5	–	–	–	–	351.4	1438.3	129.3
1981	595.1	155.0	130	219.5	66.5	69	39	–	379.8	1653.9	149.0
1982	607.8	155.0	130	219.5	66.5	69	39	551.6	648.8	2487.2	224.0
1983	620.5	155.0	130	227.7	70.0	69	39	567.8	648.8	2527.8	227.3
1984	627.0	155.0	130	244.0	70.0	69	39	584.0	648.8	2566.8	231.5
1985	627.0	155.0	130	244.0	70.0	69	39	594.8	648.8	2577.6	231.7
1986	627.0	155.0	130	244.0	70.0	69	39	605.6	648.8	2588.4	232.5
1987	627.0	155.0	130	244.0	70.0	69	39	621.8	648.8	2604.6	234.0
1988	627.0	155.0	130	244.0	70.0	69	39	643.4	648.8	2626.2	236.0
1989	627.0	155.0	130	244.0	70.0	69	39	643.4	648.8	2626.2	236.0
1990	627.0	155.0	130	244.0	70.0	69	39	660.0	648.8	2642.8	238.1

Col. (1) Shows the period of study.

Col. (2), (3), (4), (5), (6), (7), (8), and (9) lists each year the total cost of the corresponding hydro plant in millions of US$.

Col. (10) lists the transmission costs in millions of US$.

Col. (11) lists each year the total cost of all the hydro additions and corresponds to the sum of Cols. – (2), (3), (4), (5), (6), (7), (8), (9) and (10), in millions of US$.

Col. (12) lists the annual charges of all the hydro additions and corresponds to 9% of Col. (11). This – cost is also in millions of US$.

Table nº 3.19. Computation of the Annual Charges of Hydro Additions in Sequence B

Year (1)	Capi. (2)	Ãgua Verm. (3)	Canoas (4)	Pirajú (5)	Taqua. (6)	Prom. (7)	Ilha Solt. (8)	Ilha Grande (9)	Trans. Costs (10)	Total Cost (11)	Annual ch. of hydro (9%) (12)
1970		-	-			-	-	-	-	-	-
1971	-	-	-	-	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-	-	-	-	-
1973	139.5	-	-	-	-	-	-	-	38.4	177.9	16.0
1974	147.2	203.2	-	-	-	-	-	-	134.9	485.3	43.6
1975	155.0	215.5	-	-	-	-	-	-	134.9	505.4	45.5
1976	155.0	223.6	64.4	39	-	-	-	-	143.3	625.4	56.3
1977	155.0	223.7	69.0	39	66.5	121.4	-	-	165.8	840.4	75.6
1978	155.0	223.7	69.0	39	70.0	130.0	512.7	-	379.8	1579.2	142.0
1979	155.0	231.9	69.0	39	70.0	130.0	538.1	-	379.8	1612.8	145.0
1980	155.0	236.0	69.0	39	70.0	130.0	563.5	-	379.8	1642.3	148.0
1981	155.0	244.0	69.0	39	70.0	130.0	569.9	-	379.8	1656.7	149.0
1982	155.0	244.0	69.0	39	70.0	130.0	582.6	551.6	648.8	2490.0	224.0
1983	155.0	244.0	69.0	39	70.0	130.0	601.6	573.2	648.8	2530.6	228.0
1984	155.0	244.0	69.0	39	70.0	130.0	614.3	594.8	648.8	2564.9	231.0
1985	155.0	244.0	69.0	39	70.0	130.0	620.7	600.2	648.8	2576.7	231.5
1986	155.0	244.0	69.0	39	70.0	130.0	627.0	605.6	648.8	2588.4	233.0
1987	155.0	244.0	69.0	39	70.0	130.0	627.0	621.8	648.8	2604.6	234.0
1988	155.0	244.0	69.0	39	70.0	130.0	627.0	643.4	648.8	2626.2	236.0
1989	155.0	244.0	69.0	39	70.0	130.0	627.0	643.4	648.8	2626.2	236.0
1990	155.0	244.0	69.0	39	70.0	130.0	627.0	660.0	648.8	2642.8	238.1

Col. (1) shows the period of study.
Cols. (2), (3), (4), (5), (6), (7), (8), and (9) lists each year the total cost of the corresponding hydro plant in millions of US$
Col. (10) lists the transmission costs in millions of US$.
Col. (11) lists each year the total cost of all the hydro additions and corresponds to the sum of Cols.(2), (3), (4), (5), (6), (7), (8), (9) and (10), in millions of US$.
Col. (12) lists the annual charges of all the hydro additions and corresponds to 9% of Col. (11). This Cost is also in millions of US$.

Table nº 3.20. Cost Analysis of Sequence A – Computation of Total Annual Costs

Year (1)	Acc. Hydro Additions (2)	Acc. Oil Th. Additions (3)	Acc. Nuclear Additions (4)	Annual Cost Hydro (5)	Fixed Annual Cost Oil Th. (6)	Fixed Annual Cost Nuclear (7)	Total Annual Fuel Cost (8)	Total Annual Cost (9)
1971	300	-	-	-	-	-	.20	.20
1972	300	-	-	-	-	-	.64	.64
1973	980	-	-	66.0	-	-	.85	66.85
1974	1460	-	-	67.6	-	-	.67	68.27
1975	1940	-	-	69.4	-	-	.29	69.69
1976	2580	-	-	86.5	-	-	.59	87.09
1977	3110	-	-	100.0	-	-	.67	100.67
1978	3110	200	-	100.0	4.7	-	.73	105.43
1979	3430	600	-	101.0	14.2	-	1.99	117.19
1980	4120	600	-	129.3	14.2	-	13.10	156.60
1981	5070	600	-	149.0	14.2	-	12.20	175.40
1982	6030	600	-	224.0	14.2	-	13.20	251.40
1983	7140	600	-	227.3	14.2	-	12.53	254.03
1984	8240	600	-	231.5	14.2	-	13.20	258.90
1985	8560	600	1000	231.7	14.2	30.8	13.40	290.10
1986	8880	600	2000	232.5	14.2	61.6	20.52	328.82
1987	9360	600	3000	234.0	14.2	92.4	28.05	368.65
1988	10000	600	4000	236.0	14.2	123.2	34.36	407.76
1989	10000	1600	5000	236.0	37.8	154.0	44.08	471.88
1990	10480	1600	6000	238.1	37.8	184.8	67.20	527.90

Col.(1) shows the load years. A period of 20 years was studied.
Col.(2) shows the accumulated hydro additions to the system at the end of the year. The figures are listed in MW.
Col.(3) shows the accumulated oil fired thermal additions to the system, in MW.
Col.(4) shows the accumulated nuclear thermal additions to the system, in MW.
Col.(5) shows the annual cost corresponding to the hydro additions, in millions of US$.
Col.(6) shows the fixed annual cost of the oil fired thermal additions to the system, in millions of US$.
Col.(7) shows the fixed annual cost of the nuclear thermal additions, in millions of US$.
Col.(8) shows the total annual cost of fuel, in millions of US$, which is the same as variable annual charges.
Col.(9) shows the total annual cost of Sequence A for every load year, in millions of US$.

Table nº 3.21   Cost Analysis of Sequence A - Computation of Total Annual Costs

Year (1)	Total Annual Cost (9)	P.V. Factor (10)	P.V. of Total Annual Cost (11)
1971	.20	.926	.18
1972	.64	.857	.55
1973	66.85	.794	53.10
1974	68.27	.735	50.20
1975	69.69	.681	47.40
1976	87.09	.630	54.80
1977	100.67	.583	62.20
1978	105.43	.540	56.95
1979	117.19	.500	58.60
1980	156.60	.463	72.60
1981	175.40	.429	75.25
1982	251.40	.397	99.80
1983	254.03	.368	93.50
1984	258.90	.341	88.30
1985	290.10	.315	91.10
1986	328.82	.292	96.00
1987	368.65	.270	99.50
1988	407.76	.250	102.00
1989	471.88	.232	109.30
1990	527.90	.214	113.00
		Total Present Value: P=1424.33 (Jan. 1971)	

Col. (1) shows the load years.
Col. (9) shows the total annual cost for every load year in millions of US$.
Col. (10) lists the "present value" factor that corresponds to a discount rate of 8 per cent per year.
Col. (11) shows the present (1971) value of the figures of Col (9). At the bottom of the table the total of these figures is given in millions of US$.

The fixed annual charges of the existing system have not been entered, since they are the same for both sequences; therefore, they have no bearing on the sequential analysis.

Table nº 3.22. Cost Analysis of Sequence B - Computation of Total Annual Costs

Year (1)	Acc. Hydro Additions (2)	Acc. Oil Th. Additions. (3)	Acc. Nuclear Additions (4)	Annual Cost Hydro (5)	Fixed Annual Cost Oil Th. (6)	Fixed Annual Cost Nuclear (7)	Total Annual Fuel Cost (8)	Total Annual Cost (9)
1971	300	–	–	–	–	–	.20	.20
1972	300	–	–	–	–	–	.64	.64
1973	620	–	–	16.0	–	–	.85	16.85
1974	1010	–	–	43.6	–	–	.85	44.45
1975	1515	–	–	45.5	–	–	.82	46.32
1976	2035	–	–	56.3	–	–	.73	57.03
1977	2515	–	–	75.6	–	–	.85	76.45
1978	3185	–	–	142.0	–	–	.85	142.85
1979	4055	–	–	145.0	–	–	.85	145.85
1980	4810	–	–	148.0	–	–	.70	148.70
1981	5200	600	–	149.0	14.2	–	.76	163.96
1982	6160	600	–	224.0	14.2	–	13.00	251.20
1983	7280	600	–	228.0	14.2	–	12.78	254.98
1984	8240	600	–	231.0	14.2	–	11.96	257.16
1985	8560	600	1000	231.0	14.2	30.8	12.92	288.92
1986	8880	600	2000	233.0	14.2	61.6	26.95	335.75
1987	9360	600	3000	243.0	14.2	92.4	28.05	368.65
1988	10000	600	4000	236.0	14.2	123.2	34.36	407.76
1989	10000	1600	5000	236.0	37.8	154.0	44.08	471.88
1990	10480	1600	6000	238.1	37.8	184.8	67.20	527.90

Col. (1) Shows the load years. A period of 20 years was studied.
Col. (2) shows the accumulated hydro additions to the system. The figures are listed in MW.
Col. (3) shows the accumulated oil thermal additions to the system, in MW.
Col. (4) shows the accumulated nuclear thermal additions to the system, in MW.
Col. (5) shows the annual cost corresponding to the hydro additions in millions of US$.
Col. (6) shows the fixed annual cost of the oil fired thermal additions in millions of US$.
Col. (7) shows the fixed annual cost of the nuclear thermal additions in millions of US$.
Col. (8) shows the total annual cost of fuel, in millions of US$, which is the same as variable annual charges.
Col. (9) shows the total annual cost of Sequence B for every load year, in millions of US$.

Table nº 3.23. Cost Analysis of Sequence B - Computation of Total Annual Costs

Year (1)	Total Annual Cost (9)	P.V. Factor (10)	P.V. of Total Annual Cost (11)
1971	.20	.926	.18
1972	.64	.857	.55
1973	16.85	.794	13.38
1974	44.45	.735	32.60
1975	46.32	.681	31.50
1976	57.03	.630	35.85
1977	76.45	.583	44.50
1978	142.85	.540	77.00
1979	145.85	.500	72.80
1980	148.70	.463	68.80
1981	163.96	.429	70.40
1982	251.20	.397	99.70
1983	254.98	.368	93.80
1984	257.16	.341	87.60
1985	288.92	.315	91.00
1986	335.75	.292	98.00
1987	368.65	.270	99.50
1988	407.76	.250	102.00
1989	471.88	.232	109.30
1990	527.90	.214	113.00
		Total Present Value: P=1341.46 (Jan. 1971)	

Col. (1) shows the load years.
Col. (9) shows the total annual cost for every load year in millions of US$
Col. (10) lists the "present value" factor that corresponds to a discount rate of 8 per cent per year.
Col. (11) shows the present (1971) value of the figures of Col. (9). At the bottom of the table the total of these figures is given in millions of US$.

The fixed annual charges of the existing system have not been entered, since they are the same for both sequence; therefore, they have no bearing on the sequential analysis.

Chapter 4

Conclusions and Recommendations

In the present example of comparison between Sequence A and B we found Sequence B of power development cheaper and therefore more attractive. In spite of the incertainties involved with this result it is an indication that the construction of Ilha Solteira power plant represents a very high initial investment that could have been postponed for a later date if looking only at the economic point of view.

We hope to have showed how important is the study of alternative sequences of power development and how to conduct an economic evaluation of them. Having gone through these studies will enable us to know which is the most economic sequence and how much is costs to move from the most economic one to another if this has to be done by reasons other than purely economic. These reasons could be, for example the attendance to some intangible social benefits defined as national wellfare policy. It is obvious to say that these studies may represent a lot of savings in the cost of power. Some engineers and economists get so much tied up to the alternative indicated from the economic point of view that they forget the existance of alternatives that may be more interesting when considering other points of view. The engineers must always supply the decision makers with more than one alternative and point out everything that is involved with each one. They must also show the assumptions that were made during the studies and what are the incertainties involved with them. It is obvious that such long-term studies are very sensitive to the assumptions that are being made. In order to quantify the intertainties introduced by the assumed economic parameters, it is recommended to make a sensitive analysis before taking any decision. For example, one important item is the discount rate to determine the present value of annual costs. In our study we assumed to be equal to the interest rate of 8% which is conventional practice. However one could think of applying a higher discount rate to reflect the incertainties of our estimates of load growth and construction costs.

The fact of this study having lacked precision in many aspects is justified for simplifications and assumptions are necessary tools.

In this study they were of different kinds:

- some were typical of preliminary studies.
- some are of common use when we do not have the time available for more precision. We must state clear all the simplifications and assumptions that were made during the studies and not take at the end any conclusions that are inconsistent with them.
- some are frequently used when we are trying to emphasize one aspect of the study, here the methodology of the economic analysis and not, for example, the regulation of reservoirs.

We should observe that this study had not the intention to take conclusions of the sort, Sequence A is better than Sequence B or vice-versa. We wanted to show how to conduct a sequential analysis study and how to calculate a cost associated to each sequence that enables us to compare one another. We also wanted to show the difference in the schedule of some power plants, like in our example, can mean considerable difference in the cost of the sequence.

We sould note that the real study of programming the future generating capacity additions of a power system would have meant the investigation of a large number of alternative sequences. The investigation of only two sequences is not more than a first approach to the problem and in this study was only to be an example to explain the methodology used. To find the optimum sequence involves a very large amount of work and turns out to be in a sense a repetitive operation.

We should remember that we have dealt all the time through our study with CESP system considering it isolated from the rest of the power systems of other utilities in the South Central Region. This is not the way it should have been done. We should have looked upon CESP's system integrated in the region and study sequences of power development for the whole South Central Region. In its Power Market Study (R-6), ELETROBRÁS states very well: "The fact that sales contracts have been arranged between FURNAS and a number of companies and between CESP and several companies, should not be used to justify the fact that the market for the amounts of power exists, that is, the growth prospects of individual companies should be based on conditions in the respective systems and not in the first instance on contractual commitments." It also says that starting in 1975 there will be interconnection facilities for the transfer of power among the utility companies in the region.

In our study although the consideration of the whole South Central Region system would have complicated the analysis with no benefit in return regarding the prèsentation of the Sequential Analysis Methodology. The fact of having a much larger system would have involved a larger number of power plants, streamflow records, etc. and the work of gathering information would have been more tiresome, in that case coming from different companies.

It is easy to see that the methodology of analysis would not have changed whether the system was larger or smaller. What would have changed would have only been the amount of work involved. Another aspect is that, turning the system more complex would have been of negative value in our presentation and explanations of the sequential analysis. Our objective was always to keep the analysis as simple as possible to be easier for the reader to follow our presentation.

Bibliography

References

R-1 Benedict, M., Electric Generating Prospects for Nuclear Power, Spectrum, Publication of the Institute of Electrical and Electronics Engineers, Inc., (July, 1970).

R-2 Centrais Eletricas de São Paulo, Annual Report, 1968 and 1970.

R-3 Kuiper, E., Water Resources Development, (London: Butterworths, 1965)

R-4 Kuiper, E., Water Resources Project Economics, (unpublished).

R-5 Report to the Brazilian Government prepared by CANAMBRA Engineering Consultants Limited, "Power Study of South Central Brazil", (December, 1966).

R-6 Report by Centrais Eletricas Brasileiras - ELETROBRÁS, "Power Market Study and Forecast", South Central Region Brazil" Historical Evolution - Projections through 1985, (June, 1969).

R-7 Report to Centrais Eletricas de São Paulo - CESP, prepared by Sanderson and Porter, Inc. and Serviços Eletrotécnicos Ltda. (SELTEC), (February, 1970).

R-8 Report of the International Atomic Energy Agency to the Government of Brazil, James Lane, chairman, "Study of Nuclear Power for South Central Brazil".

R-9 U.S. Atomic Energy Commission, Trends in the cost of Light Water Reactor power for utilities, Wash-1150, prepared by United Engineers and Construction, Inc., (May, 1970).

R-P Private Communication