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# LOAN APPLICATION FOR

# KOREA NUCLEAR UNITS 7&8

## KOREA ELECTRIC COMPANY



Submitted to:  
The Export-Import Bank  
of the United States  
September 1979

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## 1.0 SUMMARY

### 1.1 INTRODUCTION

The Republic of Korea has experienced rapid economic development and GNP growth rates which, over the past decade, have been among the highest of all non-oil producing developed and developing countries. This rapid industrial growth has led to a continuing effort by the Republic of Korea to provide increased electrical generating capacity to support further growth.

The latest Long-Range Power Development Program, formulated by the Korean Electric Company (KECO) in conjunction with Government planning agencies, forecasts that electricity demand will experience an average annual growth rate of 16.4 percent between 1977 and 1981, decreasing to 13.1 percent during the 1982 to 1986 period. In order to partially meet these growth projections in the most economic manner, while also diversifying the fuel sources of base load electric generation for economic and strategic reasons, KECO has decided to construct two additional nuclear power plants. These plants, referred to as Korea Nuclear Units 7 and 8, will represent the sixth and seventh nuclear plants ordered by KECO. A review of the current power situation in Korea and the latest Long-Range Power Development Program are presented in Section 5 of this Application, and the financial impact of this program on KECO is presented in Section 6.

growth  
projections

### 1.2 PROJECT DESCRIPTION

The proposed Korea Nuclear Unit 7 and 8 will be located at Gyaema-Ri on the southwestern coast of the Korean peninsula. (Refer to Figure 1.2-1.) The Gyaema site was selected after extensive site investigation studies indicated it to be most suitable relative to the numerous criteria assessed. Korea Nuclear Units 1, 2, 5 and 6 are located at Ko-Ri on the southeastern coast of Korea, and the Nuclear Unit at Weolsong is located about 50 kilometers north of Ko-Ri.

The Korea Nuclear Units 7 and 8, which are planned as base load plants, will be designed to have a net output of approximately 950 MWe each, for a total capacity of 1900 MWe. The units will consist of pressurized water reactors (PWR) and turbine generators to be supplied by Westinghouse Electric Corporation, together with necessary supporting balance of plant (BOP) equipment. The PWR type of reactor is widely accepted for power plant application.

Wt PWR

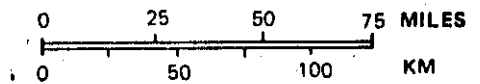
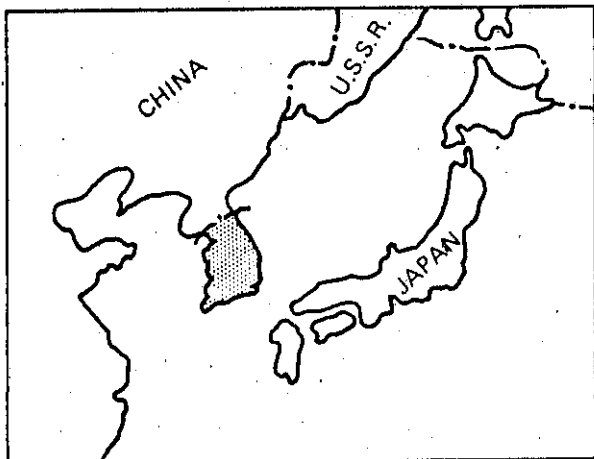
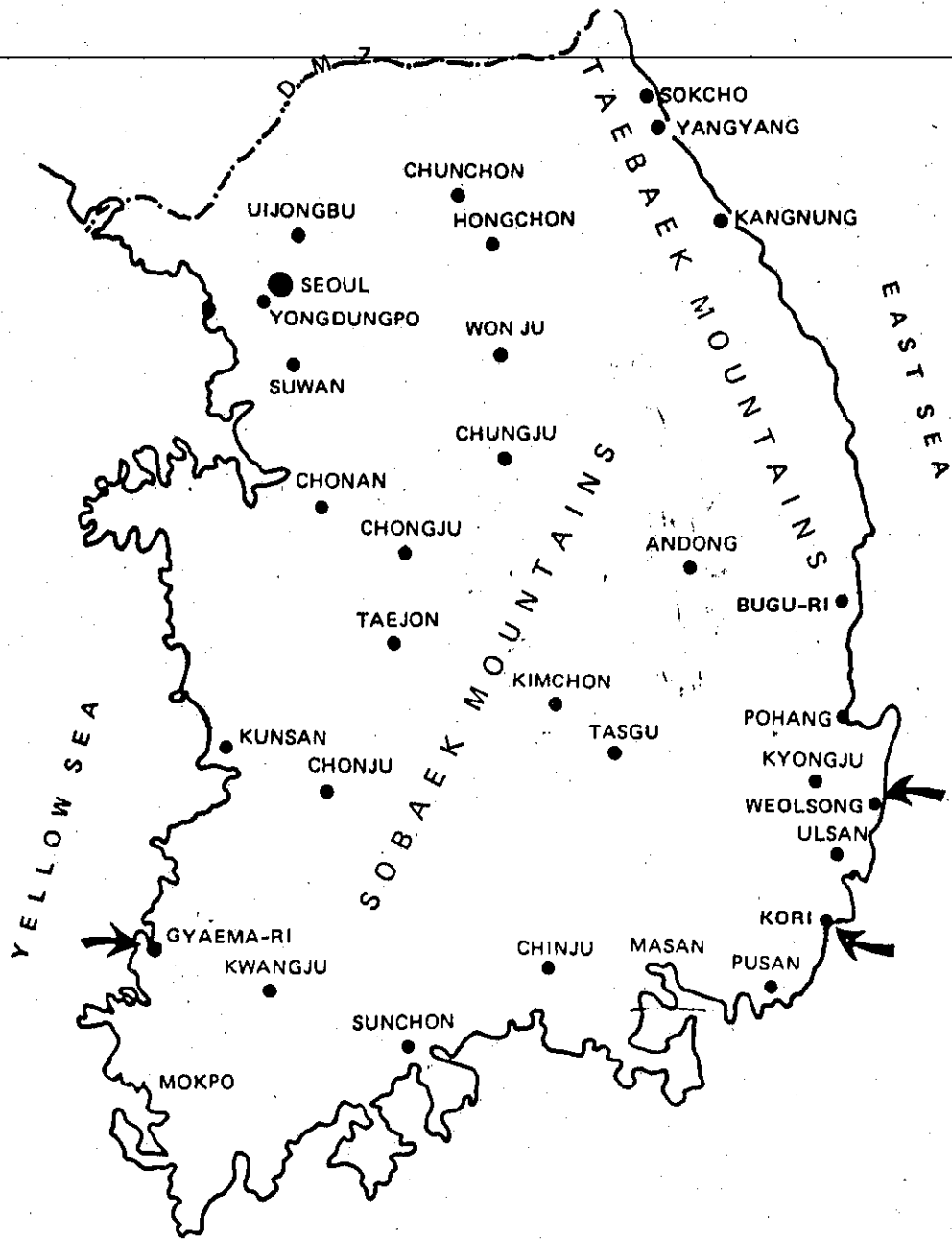
Bechtel  
design

GEC.  
conventional  
(turbines)

The project is scheduled to start in September 1979, with commercial operation scheduled for March 30, 1986 and March 30, 1987 for Units 7 and 8, respectively. A description of the project, including a discussion of the plan of execution for implementation of the project, is presented in Appendix A of this Application.

### 1.3 PROJECT EXECUTION

KECO intends to execute the project using the "component" approach for Project Implementation. With the component approach, project management, engineering and design of the plant, procurement of equipment and materials, construction management, installation, preoperational testing, startup, and quality assurance will be the responsibility of KECO and an engineer construction (EC) manager. Westinghouse Electric Corporation has been selected to supply the Nuclear Steam Supply System (NSSS) and turbine-generator (T/G) equipment on an equipment



	<p><b>KOREA ELECTRIC COMPANY</b>  <b>KOREA NUCLEAR</b>  <b>UNITS 7 &amp; 8</b></p>
<p>REPUBLIC OF KOREA MAP AND GYAEMA-RI          FIGURE 1.2-1</p>	

supply basis, including the initial fuel fabrication, supply of basic engineering design criteria for the balance of plant, and certain technical support services.

All engineering and design of the balance of plant, and procurement of equipment and materials including the condensing, feedwater, and extraction systems, as well as controls, piping and pedestal work, will be performed by a U.S. EC organization to be selected. The erection and installation work will be managed by KECO and the EC, and carried out by local labor and subcontractors, with participation and support from the NSSS and T/G supplier as necessary.

Bevel..

#### 1.4 PROJECT FUEL SUPPLY

The projected world supply/demand situation for uranium ore has improved substantially during the past few years as a result of the slowdown in U.S. nuclear power expansion and an increase in U.S. as well as worldwide production capacity. During the past two years, about 70 nuclear plants have been delayed by U.S. utilities and, since 1974, 16 percent of the proposed U.S. nuclear capacity has been canceled outright. More recently, the Three Mile Island accident has resulted in further delays in nuclear reactor programs – both in the U.S. and worldwide. At the same time, uranium supplies have been increasing – with recent discoveries of deposits in Canada and Australia, and more production capacity being put in place. Consequently, the world spot market and prices for uranium are currently soft, and long-term supply is projected to be quite ample through the year 2000 without significant additional discoveries.\*

U.S.  
235.

In recognition of this environment, KECO purchased most of its uranium requirements through 1981 for its first three nuclear units on the world spot market, and plans to use its spot purchase program to secure some of the initial core requirements for Korea Nuclear Units 7 and 8. However, KECO's overall procurement strategy is to secure the larger portion of its fuel requirements through long-term uranium purchase contracts. To implement this strategy, KECO is currently negotiating with several companies in the U.S., Canada, and Australia, and expects to finalize two or three long-term supply contracts by the end of 1979.

In addition to long-term purchase contracts, KECO has been participating with two foreign partners since 1977 in a joint venture exploration project of uranium properties in South America. Further, KECO is in the final stage of concluding a tripartite joint venture agreement on an exploration project in Africa. Finally, KECO is working to secure direct participation in actual production activities by acquisition and development of proven reserves in the U.S.; several proposals for the joint venture development of proven reserves were received by KECO in 1978 from U.S. uranium property owners. KECO has hired a U.S. consultant to evaluate the proposed uranium properties, and shortly expects the results of the consultant's feasibility study of one of the U.S. properties proposed.

The total enrichment services required from the U.S. Department of Energy to provide fuel for KECO's nuclear plants (including Units 7 and 8) are 5,132 MWe. Although this enrichment volume slightly exceeds the 5,000 MWe ceiling stipulated in the ROK-U.S. Bilateral Agreement, the U.S. Congress and Senate are presently studying the need to increase this ceiling by about 10 percent and it is anticipated that the Agreement will be amended prior to the first delivery of enriched uranium scheduled for late 1984.

\* "Forecast of Nuclear Power and Nuclear Fuel Requirements", C. R. Glassey, R. G. Clark; Energy Information Administration, U. S. Department of Energy. Paper presented at the Atomic Industrial Forum Fuel Cycle Conference, 1979, Atlanta, GA.



## 1.5 PROJECT COST AND FINANCING PLAN

The total cost of the project is estimated at \$2627.8-million, including direct construction costs, owner's indirect costs, interest during construction and other financial costs, and initial fuel cores for the two units. The breakdown of the estimated project costs is presented in Section 2 of the Application.

2.63  
billion  
for  
1900 M  
in \$1979.

The financing plan proposed for this project will provide for its total funding, and the project will generate cash flows sufficient to repay the debt on a timely basis with a substantial safety margin. The financing plan will draw upon a direct loan from the Export-Import Bank of the United States (Eximbank Direct Loan), a loan guaranteed by Eximbank provided by the Private Export Funding Corporation (PEFCO), a Commercial/KFX Loan,\* and equity funding to be provided by KECO. Table 1.5-1, Summary of Project Costs and Financing Plan, presents a summary breakdown of the U. S. and Korean project costs and the proposed financing to be obtained to fund each cost. The financing plan, including anticipated terms and conditions for each project loan, is presented in Section 3 of this Application.

## 1.6 ECONOMIC EVALUATION – NUCLEAR VS. OIL VS. COAL

KECO has determined that the proposed Korea Nuclear Units 7 and 8 will be more economical than equivalent oil-fired or coal-fired plants. According to an economic analysis comparing the 1986 unit generation costs per kWh of twin 1000-MWe nuclear units and equivalent oil-fired and coal-fired units, the nuclear cost was 33.2 mills/kWh compared with 57.6 mills/kWh for the oil-fired units and 42.7 mills/kWh for the coal-fired units.

< costs than  
oil/coal.

In addition to the advantage of lower generating costs, the nuclear units are also expected to produce about \$6,631 million in net cumulative foreign exchange savings for Korea compared to the oil-fired plants — and \$2,528 million in savings compared to the coal-fired plants — through a period from 1986 to 1997. The generation cost and foreign exchange savings of the nuclear units are evaluated in Section 4 of this Application.

for exch  
savings.

## 1.7 BENEFITS OF NUCLEAR PLANT EXPORT

An analysis of the U. S. exports associated with Korea Nuclear Units 7 and 8 indicates that they will have a significant impact on the U. S. balance of trade and the creation of employment during the planned seven year design and construction period. The proposed units are expected to generate \$1,101 million of U. S. exports, including materials and equipment, engineering and construction services, and nuclear fuel supply. Moreover, these exports will create an estimated 49,600 man-years of employment in the U. S., consisting of 24,800 man-years of direct employment and approximately 24,800 man-years of indirect employment associated with a project of this type. Finally, about 1,200 suppliers and subcontractors for equipment and services will be involved — distributed among about 250 cities in 40 states.

1.101 M  
US exports =  
42% of total  
costs.

A description of this evaluation and its detailed results are presented in Appendix D of this Application.

\* A commercial loan that KECO plans to secure from the Korean Foreign Exchange Bank.

Table 1.5-1  
**SUMMARY OF PROJECT COSTS AND FINANCING PLAN  
 CONSTRUCTION PERIOD 1979-1987**

*In unescalated \$'s  
 in escalated \$'s*

Millions of U. S. \$

**PROJECT COSTS**

U. S. Costs

Capital Costs	\$918.6	
Fuel Costs	182.9	
Subtotal		\$1101.5

<u>Third Country Procurement</u>		\$ 11.9
----------------------------------	--	---------

Korean Costs

Capital Costs	\$931.0	
Owner's Costs	162.9	
Subtotal		\$1093.9

<u>Financial Charges</u>		\$ 420.5
--------------------------	--	----------

TOTAL		\$2627.8
-------	--	----------

**FINANCING PLAN**

Eximbank Direct Loan

Plant	\$780.8	
Fuel	155.5	
Subtotal		\$ 936.3

<u>Eximbank Guaranteed Loan (PEFCO)</u>		\$ 165.2
---	--	----------

<u>KECO Funding (incl. Commercial/KFX Loan)</u>		\$1526.3
---	--	----------

TOTAL		\$2627.8
-------	--	----------

*KEB*

Table 2.2-1  
 BREAKDOWN OF CAPITAL COST ESCALATED DOLLARS  
 (U. S. \$ Thousands)

485 WON/\$

Item	U. S. Costs	Third Country Procurement	Korean Costs	Total
NSSS Equipment (Westinghouse)				
T/G Equipment (Westinghouse)				
<u>Other Equipment and Material</u>	382,166		256,280	638,446
<u>Construction</u>	75,681		442,426	518,107
Engineering and Services	55,504			55,504
Project Contingency	<u>51,783</u>		<u>56,496</u>	<u>108,279</u>
Subtotal	810,473	10,813	840,174	1,661,460
Owner's Administrative Costs			53,000	53,000
Custom Duties & Handling Charges			109,900	109,900
<i>new category</i> Owner's Contingency	<u>108,094</u>	<u>1,081</u>	<u>90,825</u>	<u>200,000</u>
Subtotal	<u>108,094</u>	<u>1,081</u>	<u>253,725</u>	<u>362,900</u>
Total Capital Cost (Excluding Initial Fuel Core and Financial Cost)	918,567	11,894	1,093,899	2,024,360
Financial Cost				420,491
Total Capital Cost (Excluding Initial Fuel Cores)				<u>2,444,851</u>

*produce goods*  
 = L

*incl  
 list during  
 cost = 27*

*46%  
 Σ = 2012.5*

- The Other Equipment and Material estimate of \$638.4 million consists of \$382.2 million to be procured in the U. S. and \$256.2 million to be procured in Korea. This estimate includes all material and equipment which will become a permanent part of the plant excluding the NSSS and T/G equipment. It also includes construction materials, such as concrete forms, which can be directly charged to specific structures.
- The Construction Costs estimate of \$518.1 million includes all construction site labor, subcontractor's fees, and construction tools/equipment. It also includes temporary structures and miscellaneous materials which cannot be charged directly. As shown in Table 2.2-1, the major portion of Construction Costs will be incurred in Korea.
- The Engineering and Services estimate of \$55.5 million includes all engineering and services performed away from the construction site except for those performed by equipment vendors.
- The Project Contingency estimate of \$108.3 million is defined as the amount of money which must be included in an estimate to achieve a desired level of confidence in that estimate by providing for uncertainties — in quantity, pricing, productivity, and schedule — which lie within the defined scope of the project. Project contingency excludes uncertainties beyond the engineer's control which are provided for in Owner's Contingency below.
- The Owner's Administrative Costs estimate of \$53.0 million represents KECO's costs associated with the planning, construction and initial operation of the units.
- The Custom Duties and Handling Charges estimate of \$109.9 million represents KECO's costs associated with bringing foreign-procured equipment and materials for the project into Korea.
- The Owner's Contingency estimate of \$200.0 million is the amount of money which an owner includes in an estimate to allow for deviations which cannot be specifically identified and are not included in the Project Contingency. Owner's Contingency includes allowances for possible cost changes arising from present plans for physical plant components, plant arrangement or siting, design criteria, codes and standards imposed by the client or regulatory agencies, vendor design criteria, scope of services or division of responsibility, exchange rates, and inflation rates.
- The Financial Costs estimate of \$420.5 million includes interest, commitment and management fees, and export credit guarantee fees associated with each of the loans in the proposed financing plan described in Section 3 of this Application.

### 2.3 INITIAL FUEL CORES COST

The total cost of initial fuel cores for Nuclear Units 7 and 8 is estimated to be \$182,900,000 over the 1982-1986 period. This estimate consists of the costs shown in Table 2.3-1.

(no interest)

Table 2.3-1  
SUMMARY OF INITIAL FUEL CORES COST  
(U. S. \$ Thousands)

U <sub>3</sub> O <sub>8</sub>		\$	Escalation rate 5%
Conversion			6%
Enrichment		59,000 *	10%
Fabrication			7%
Total		\$182,900	

\* Excludes advance payment of \$6.3 million made by KEPCO to U.S. D.O.E. in 1979.

The factors used in determining these Initial Fuel Cores Cost include the following:

1. The current cost of U<sub>3</sub>O<sub>8</sub> was assumed to be \_\_\_\_\_, including transportation and insurance costs.
2. A current cost of \_\_\_\_\_ per Kg U for conversion. Losses were assumed to be 0.5 percent in the conversion process.
3. Enrichment services were based on assumed commercial cost of about \$100.00 per \_\_\_\_\_ separative work unit (SWU).
4. Fabrication costs were based on current offers.
5. Escalation rates applied for the cost estimates of each fuel cycle component — uranium concentrate, conversion, enrichment, and fabrication — are 5, 6, 10, and 7 percent per year, respectively.
6. Interest charges associated with fuel core procurement have been excluded from this computation.

The preliminary procurement plan for the initial fuel cores results in the annual costs summarized in Table 2.3-2. This table indicates that the major fuel core expenditures occur in the 1982 to 1986 period.

**Table 2.3-2  
INITIAL FUEL CORES COST  
(U. S. Millions)**

<u>Component</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>Total</u>
U Ore						
Conversion						
Enrichment						59.0 *
Fabrication						
<b>Total</b>						<b>182.9</b>

\* Excludes advance payment of \$6.3 million made by KECO to U.S. D.O.E. in 1979.

Table 3.2-1  
SUMMARY OF PROJECT COSTS AND FINANCING PLAN

	<u>Millions of U. S. \$</u>	<u>Percent of Total</u>
<b>PROJECT COSTS</b>		
<u>U. S. Costs</u>		
Capital Costs	\$ 918.6	
Fuel Costs	<u>182.9</u>	
Subtotal	\$1101.5	41.9
<u>Third Country Procurement</u>	\$ 11.9	0.5
<u>Korean Costs</u>		
Capital Costs	\$ 931.0	
Owner's Costs	<u>162.9</u>	
Subtotal	\$ 1093.9	41.6
<u>Financial Charges</u>	\$ 420.5	<u>16.0</u>
<b>TOTAL</b>	<b>\$2627.8</b>	<b>100.0</b>
<b>FINANCING PLAN</b>		
<u>Eximbank Direct Loan</u>		
Capital Cost Commitment	\$ 780.8	
Fuel Core Commitment	<u>155.5</u>	
Total Commitment	\$ 936.3	35.6
<u>Eximbank Guaranteed Loan (PEFCO)</u>	\$ 165.2	6.3
<u>KECO Funding</u>		
Equity	\$1101.3	
Commercial KFX Loan	<u>425.0</u>	
Subtotal	\$1526.3	<u>58.1</u>
<b>TOTAL</b>	<b>\$2627.8</b>	<b>100.0</b>

repayment period, for a total term of 11 years. KECO's indebtedness under the Eximbank Direct Loan will be unconditionally guaranteed by the ROK. Other terms and conditions of the Eximbank Direct Loan are summarized in Table 3.2-2.

- Eximbank Guaranteed Loan (PEFCO)

An Eximbank Guaranteed Loan to be made by PEFCO will finance an amount equivalent to 15 percent, up to \$165.2 million, of the cost of U. S. goods and services for the project to cover a portion of Korean local costs.

PEFCO's interest rate will be fixed at 9.125 percent which, when combined with a 0.50 percent per annum guarantee fee charged by Eximbank, produces a total annual charge of 9.625 percent payable semi-annually in arrears on funds actually borrowed. The overall term of the loan will be 23 years, including 8 year grace and 15-year repayment period. Other terms and conditions of the PEFCO Loan are summarized in Table 3.2-2.

\*  
9.62%

- KECO Funding

The balance of the project funding, amounting to \$1526.3 million, will be from funds provided by KECO and will be used to cover a portion of U. S. and Korean costs and Financial Costs. The majority of this funding will be derived from direct equity contributions by KECO of \$1101.3 million. The remainder of KECO funding will be secured from a Commercial/KFX loan (a commercial loan arrangement with the Korean Foreign Exchange Bank) amounting to \$425.0 million. Although the rates and terms of this loan are preliminary at this time, it is expected that the floating interest rate will average about 10.0 percent over the total term of 12 years which includes a 78-month grace period. Although the 10 percent average interest rate assumed is substantially below the current LIBOR rate of about 12 percent, the floating rate averaged less than 5.5 percent as recently as 1976.

10%

to unrealistic rates

### 3.3 CASH FLOW ANALYSIS

Cash flow analyses were prepared and are described on the next few pages to present the annual Sources and Uses of Funds during the project's 1979-1987 construction period (Table 3.3-1) and the Projected Cash Available for Debt Service through the 1986 to 2002 period (Table 3.3-2).

- Sources and Uses of Funds

The Sources and Uses of Funds During Construction schedule is based on the project cost estimate detailed in Section 2 and on the project financing plan outlined previously in this section. The schedule provides a year by year accounting of the project expenditures. The schedule shows that total project expenditures amount to \$2627.8 million, with the major portion of this total occurring in 1983 (\$561.9 million), 1984 (\$642.0 million), and 1985 (\$593.5 million). Almost half of the Exim Direct Loan is required in 1983 and 1984, and KECO's funding requirements are the greatest from 1983 to 1985.



- Projected Cash Available for Debt Service

An analysis was prepared to estimate the cash flow from the operations of the two units which would be available to cover debt service payments. For this analysis, estimates of the annual revenues and the direct operating costs associated with operation and maintenance of the project were prepared for the 1986 to 2002 period. The results of this analysis, shown in Table 3.3-2, indicate that the debt service coverage ratio exceeds 2.5 throughout this period and that the cash flow generated by the project (over \$800 million annually after 1987) will provide a substantial margin over and above the principal and interest payment requirements.

revenue  
operating  
cost  
> cash  
flow

Assumes

3/31/86

+ 8%

Completion

TABLE 3.3-1  
KOREA NUCLEAR UNITS NO. 7 & NO. 8  
SOURCES AND USES OF FUNDS DURING CONSTRUCTION  
(MILLIONS OF U.S. DOLLARS)

Year:	1979	1980	1981	1982	1983	1984	1985	1986	1987	Total
<u>Sources of Funds</u>										
Exim Direct Loan										
Capital Cost Commitment	—	25.8	54.7	120.2	198.3	185.1	139.0	50.8	7.0	780.8
Fuel Core Commitment	—	—	—	32.5	34.3	25.6	44.0	19.0	—	155.5
PEFCO										
Capital Cost Commitment	—	5.4	11.4	27.4	41.8	38.5	30.0	9.5	1.3	165.2
KECO Funding										
Commercial KFX Loan	—	5.4	42.3	99.3	156.3	121.7	—	—	—	425.0
Equity	10.9	21.6	30.1	64.0	131.2	271.2	380.6	169.6	22.1	1101.3
Total Sources of Funds	10.9	58.2	138.5	343.5	561.9	642.0	593.5	248.9	30.4	2627.8
<u>Uses of Funds</u>										
U. S. Costs										
Capital Costs	6.4	23.9	64.3	141.5	233.3	217.7	163.5	59.7	8.3	918.6
Fuel Core Costs	—	—	—	38.2	40.4	30.1	51.8	22.4	—	182.9
Total U. S. Costs	6.4	23.9	64.3	179.7	273.7	247.8	215.3	82.1	8.3	1101.5
Korean Costs										
Korean Capital Costs	3.8	20.5	51.3	112.6	191.7	253.2	219.7	73.5	4.6	931.0
Owner's Costs	0.6	3.6	9.0	19.7	33.6	44.3	38.4	12.9	0.8	162.9
Total Korean Costs	4.4	24.0	60.2	132.3	225.3	297.5	258.2	86.4	5.5	1093.9
Third-Country Procurement	0.1	0.3	0.8	1.8	3.0	2.8	2.1	0.8	0.1	11.9
Financial Charges										
Exim Direct Loan	—	3.6	6.5	14.5	29.4	46.6	61.9	43.6	9.3	215.3
PEFCO	—	1.3	2.0	3.8	6.9	10.5	13.6	9.4	2.0	49.5
Commercial KFX Loan	—	5.1	4.6	11.4	23.5	36.7	42.5	26.6	5.3	155.7
Total Financial Charges	—	10.0	13.1	29.6	59.8	93.8	117.9	79.6	16.6	420.5
Total Uses of Funds	10.9	58.2	138.5	343.5	561.9	642.0	593.5	248.9	30.4	2627.8

Note: Numbers may not add due to rounding.

0.41% 2.2% 5.3% 13.1% 21.4% 24.4% 22.6% 9.5% 1.2%  
cum. 2.6 7.9 21.0 42.4 66.8 89.4 98.9 100.1%

TABLE 3.3-2

**PROJECTED CASH AVAILABLE FOR DEBT SERVICE (1)  
(MILLIONS OF U. S. DOLLARS)**

Year:	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>
Project Revenues	316.1	807.8	1053.7	1123.9	1123.9	1123.9
Direct Operating Cost	<u>70.7</u>	<u>164.9</u>	<u>188.4</u>	<u>188.4</u>	<u>188.4</u>	<u>188.4</u>
Cash Available for Debt Service	245.4	642.9	865.3	935.5	935.5	935.5
<u>Debt Service Requirements</u>						
Exim Direct Loan						
Amortization — Capital Cost	13.0	39.0	52.1	52.1	52.1	52.1
— Fuel Core	13.0	38.9	51.8	38.9	13.0	—
Interest — Capital Costs	23.2	52.3	56.2	52.1	47.9	43.0
— Fuel Core	<u>4.4</u>	<u>8.6</u>	<u>6.2</u>	<u>2.3</u>	<u>0.3</u>	<u>—</u>
Subtotal Exim Loan	53.5	138.8	166.3	145.3	113.2	95.1
PEFCO Loan						
Amortization	2.8	8.3	11.0	11.0	11.0	11.0
Interest	<u>5.9</u>	<u>13.3</u>	<u>14.3</u>	<u>13.3</u>	<u>12.2</u>	<u>11.0</u>
Subtotal PEFCO Loan	8.6	21.6	25.3	24.3	23.2	22.0
Commercial KFX Loan						
Amortization	17.7	53.1	70.8	70.8	70.8	70.8
Interest	<u>15.5</u>	<u>33.2</u>	<u>31.9</u>	<u>24.8</u>	<u>17.7</u>	<u>10.0</u>
Subtotal Commercial KFX Loan	33.2	86.3	102.7	95.6	88.5	80.8
Total Debt Service	95.4	246.7	294.8	265.2	224.9	199.9
<u>Net Project Cash Flow</u>						
Annual	150.0	396.2	571.0	670.3	710.6	730.0
Cumulative	150.0	546.2	1117.2	1787.5	2498.1	3234.1

## EXPLANATION OF FINANCIAL TABLES

The following pages present line descriptions for the Sources and Uses of Funds During Construction schedule and the Projected Cash Available for Debt Service schedule. These line descriptions establish the basis of the computation and the parameters assumed to determine the line entries in each of the statement. Unless otherwise indicated, all figures are expressed in terms of millions of U. S. dollars escalated to 1986. As noted in Section 2, Project Costs, foreign costs were escalated at a 7 percent annual rate while Korean costs were escalated at a 12 percent annual rate.

*should be*

### Table 3.3-1 Sources and Uses of Funds

#### Sources of Funds

**Exim Direct Loan:** The Exim Direct Loan totals \$936.3 million, representing 85 percent of total U. S. costs. The loan consists of a Capital Cost Commitment of \$780.8 million and a Fuel Commitment of \$155.5 million.

- Disbursements under the Eximbank Direct Loan will be made throughout the construction period.
- The loan amount under the Eximbank Direct Loan will be allocated between Unit 7 and Unit 8, with repayments to begin six months after completion of each nuclear unit, or September 30, 1986 for Unit 7 and September 30, 1987 for Unit 8. For the purpose of this analysis, the loan amounts are allocated evenly between Units 7 and 8, such that 50 percent (for Unit 7) of the Exim Direct Loan is repaid from 1986 to 2001, with the remaining 50 percent portion (for Unit 8) being repaid over the 1987-2002 period.
- The repayment of the Capital Cost Commitment will be in thirty equal semi-annual installments, while the repayment of the Fuel Commitment will be in six equal semi-annual installments.

**PEFCO Loan:** The PEFCO Loan totals \$165.2 million, representing 15 percent of total U. S. costs. As in the case of the Exim Direct loan, the PEFCO Loan will be disbursed throughout the construction period with repayment in thirty equal semi-annual installments beginning six months after the completion of each nuclear unit.

**KECO Funding:** The balance of funding required will be provided through KECO equity contributions and a Commercial/KFX Loan to cover foreign exchange and local costs not covered by equity.

**Total Sources of Funds:** This represents the total of the Exim Direct Loan, PEFCO Loan, and KECO Funding.

#### Uses of Funds

**U. S. Costs:** Total U. S. Costs amount to \$1101.5 million and consist of \$918.6 million Capital Costs and \$182.9 million of Fuel Cores Costs. These costs include escalation assumed to be 7 percent per annum through the construction period.

- The U. S. Capital Costs represent the value of the U. S. goods and services to be exported to the project, including NSSS equipment, T/G equipment, other equipment and materials, construction, and engineering services costs. These costs are discussed in Section 2 of this Application.
- The Fuel Cores Costs represent the U. S. cost of the initial fuel core purchase for both units and includes uranium, conversion, enrichment and fabrication costs. These costs are also discussed in Section 2.

Korean Costs: Korean Costs total \$1,093.9 million and consist of \$931.0 million of Korean Capital Costs and \$162.9 million of Owner's Costs. These costs include escalation assumed to be 12 percent per annum during the construction period.

- The Korean Capital Costs include certain equipment and materials, construction costs, and engineering and project services purchased in Korea.
- Owner's Costs represent KECO's home office costs and custom duties and handling charges associated with this project.

Financial Charges: The Financial Charges of \$420.5 million include all of the financial fees, including interest, commitment fees, management fees, and export credit guarantee fees associated with each of the loans contained in the proposed financing plan. The financial charges for each loan are summarized in Table 3.2-2 in this Section.

Total Uses of Funds. This represents the total of the Exim Direct Loan, PEFCO Loan, and KECO Funding.

#### Table 3.3-2 Project Cash Available for Debt Service

Project Revenues: The projected revenue stream from the operations of the units is based on the expected level of startup of operations from Units 7 and 8 and from the projected level of unit electricity rates during this period. Operating capacities assumed for each unit were Year 1: 60%, year 2: 70%, years 3-10: 80%, and years 11-15: 73%. Unit rates for electricity were assumed constant following the startup of operations at \$0.0856 per KWh.

Direct Operating Cost: The Direct Operating Cost includes fuel costs, operating and maintenance costs, insurance costs and other direct costs associated with the operations of the two units. These costs rise from \$70.7 million in 1986 to \$164.9 million in 1987 and \$188.4 million in 1988 and thereafter.

Cash Available for Debt Service: The Cash Available for Debt Service is calculated as Projected Revenues less Direct Operating Cost.

Debt Service Requirements: The Debt Service Requirements include the debt repayment (amortization) and interest costs, including the Eximbank guarantee fees, for each of the loans contained in the proposed financing plan. In 1986 and 1987, certain other financial costs, such as commitment fees, have been included in the interest cost figures. The Financial Charges and the repayment terms of each of the loans are summarized in Table 3.2-2 in this Section.

Net Project Cash Flow: The Net Project Cash Flow is calculated as Cash Available for Debt Service Requirements. This cash flow is calculated and shown on an annual and cumulative basis.

## 4.0 ECONOMIC EVALUATION – NUCLEAR VS OIL VS COAL

### 4.1 PROJECT ECONOMICS

An economic analysis was prepared to compare the 1986 unit generation costs per kilowatt hour of twin 1000-MWe nuclear units with four oil-fired units, each with 500 MWe gross output, and with four coal-fired units with 500 MWe output each – assuming all units were to be constructed and operated in Korea. Generation costs include fixed charges on capital, fuel, and operating and maintenance expenses. The results of the economic comparison, presented in Table 4.1-1, show that the total unit generation costs in 1986 are expected to be (U.S. \$) 33.2 mills/kWh for the nuclear units compared with (U.S. \$) 57.6 mills/kWh for the oil-fired plants and 42.7 mills/kWh for the coal-fired units. Based on this analysis, the unit generation cost of the nuclear plants operating in Korea is over 40 percent lower than the oil-fired plants and over 20 percent lower than the coal-fired plants.

*but all have same Cf.*

The assumptions used for this economic analysis include the following:

- A. The plant capital costs have been estimated to escalate by an average of 7 percent per annum, while fuel costs and operating and maintenance expenses for the nuclear, oil-fired, and coal-fired units were escalated by an average of 6 percent per annum.
- B. No transmission line costs have been included in this comparison since cost differences between the plants are considered relatively minor.
- C. Design life expectancy of the plants is considered to be 40 years; however, a 30-year economic life is used for purpose of this study for all three-types of plants.

*but we know cost = cost escalate at 12% (p2-11) = a 42% to total cost!*

*n = 30*

*to be assumed in constant (real) dollars*

**TABLE 4.1-1  
COMPARISON OF NUCLEAR, OIL-FIRED,  
AND COAL-FIRED PLANTS**

*1979 #*

Item	Nuclear Plants	Oil-Fired Plants	Coal-Fired Plants
Year of Commissioning	1986	1986	1986
Installed Capacity (MW)	2 × 1000	4 × 500	4 × 500
Unit Capital Cost (\$/KW)	1177	628	878
Plant Capacity Factor (%)	75.0	75.0	75.0
Annual Fixed Charge Rate (%)	13.3	13.3	13.3
Generation Cost (mills/kWh)			
Fixed Charge on Capital	23.9	12.7	17.8
Fuel	8.0	43.4	22.5
O&M	1.3	1.5	2.4
Total Unit Generation Cost – 1986	<u>33.2</u>	<u>57.6</u>	<u>42.7</u>

*take total k cost capacity = fixed by AFCC on k generation cost*

*unrealistic escalation of. given 1383 in (incl. escalation). + int during construction*

*x DF is too low for economic comparison at least 15%/y*

D. For the oil-fired plants, 19 million barrels of oil per year will be required for fuel at an estimated cost in 1986 of \$30 per barrel. The coal-fired plants will require 5.8 million tons of coal per year at an estimated 1986 cost of \$51 per ton.

*oil / 17  
coal / 17*

#### 4.2 FOREIGN EXCHANGE SAVINGS

Under the assumptions noted above, comparative foreign exchange flows for the nuclear, oil-fired, and coal-fired plants were estimated and are presented in Tables 4.2-1 and 4.2-2. The anticipated foreign exchange savings to Korea as a result of lower cost of nuclear fuel compared to fuel oil are estimated to average \$661 million annually and to total \$7,929 million over the 1986 to 1997 period. After adjustment for repayment of foreign loans assumed to finance 70 percent of the cost of the nuclear or oil-fired facilities, the net cumulative foreign exchange savings of the nuclear plants over the 1986 to 1997 period (the assumed debt service period for the nuclear units) are \$6,631 million.

In the case of nuclear fuel compared to coal, the foreign exchange fuel savings to Korea are estimated to average \$275 million annually and to total \$3,303 million over the 1986 to 1997 period. After adjustment for foreign loan repayments, the net cumulative foreign exchange savings of nuclear versus coal-fired plants are \$2,528 million.

Table 4.2-1  
FOREIGN EXCHANGE SAVINGS  
NUCLEAR VS OIL-FIRED PLANTS  
(Millions of U.S. \$)

*we calculate using realistic fuel & K cost figures \* id real escalation rates & int during construction.*

Year	Fuel Cost			Debt Service			Net Savings	
	Oil	Nuclear	Savings <sup>(1)</sup>	Oil	Nuclear	Savings <sup>(2)</sup>	Annual <sup>(3)</sup>	Cumulative
1986	570	100	470	167	286	(119)	351	351
1987	604	106	498	159	273	(114)	384	735
1988	640	112	528	151	261	(110)	418	1153
1989	679	119	560	143	248	(105)	455	1608
1990	720	126	594	135	236	(101)	493	2101
1991	763	134	629	127	224	(97)	532	2633
1992	809	142	667	120	212	(92)	575	3208
1993	857	151	706	112	199	(87)	619	3827
1994	908	159	749	104	187	(83)	666	4493
1995	963	169	794	96	174	(78)	716	5209
1996	1021	179	842	-	162	(162)	680	5889
1997	1082	190	892	-	150	(150)	742	6631
TOTAL			7929			(1298)	6631	

*286  
119  
167*

NOTES:

- (1) Oil-Fired plant fuel costs minus nuclear plant fuel costs.
- (2) Oil-Fired plant debt service minus nuclear plant debt service.
- (3) Annual net savings = in fuel cost plus savings in debt service.

**Table 4.2-2**  
**FOREIGN EXCHANGE SAVINGS**  
**NUCLEAR VS COAL-FIRED PLANTS**  
(Millions of U.S. \$)

Year	Fuel Cost			Debt Service			Net Savings	
	Coal	Nuclear	Savings <sup>(1)</sup>	Coal	Nuclear	Savings <sup>(2)</sup>	Annual <sup>(3)</sup>	Cumulative
1986	296	100	196	234	286	(52)	144	144
1987	313	106	207	223	273	(50)	157	301
1988	332	112	220	211	261	(50)	170	471
1989	352	119	233	200	248	(48)	185	656
1990	373	126	247	189	236	(47)	200	856
1991	396	134	262	178	224	(46)	216	1072
1992	420	142	278	167	212	(45)	233	1305
1993	445	151	294	156	199	(43)	251	1556
1994	472	159	313	145	187	(42)	271	1827
1995	500	169	331	134	174	(40)	291	2118
1996	530	179	351	—	162	(162)	189	2307
1997	561	190	371	—	150	(150)	221	2528
<b>TOTAL</b>			<u>3303</u>			<u>(775)</u>	<u>2528</u>	

NOTES:

- (1) Coal-fired plant fuel costs minus nuclear plant fuel costs.
- (2) Coal-fired plant debt service minus nuclear plant fuel costs.
- (3) Annual net savings — savings in fuel cost plus savings in debt service.



## 5.0 KECO POWER DEVELOPMENT PROGRAM

### 5.1 GENERAL

Korea's rapid transition from an agricultural to an industrial economy is directly and drastically reflected in power consumption. For example, power sales have increased at an annual rate of 17.2 percent in the period from 1972 through 1976. The increase is projected to be 16.4 percent in the period from 1977 through 1981, and at an annual rate of 13.1 percent from 1982 through 1986.

KECO has managed to meet these demands by adding new plants at a carefully planned rate of expansion. Installed capacity increased 19.4 times from 1961 to 1978. Planned expansion will increase the installed capacity by 3.5 times from 1978 to 1988 in order to meet forecast load demand and improve the amount of reserve capacity over peak demand. Present electrical power reserve margins are 7.7 percent, but are expected to improve to a more satisfactory 17.7 percent in 1988.

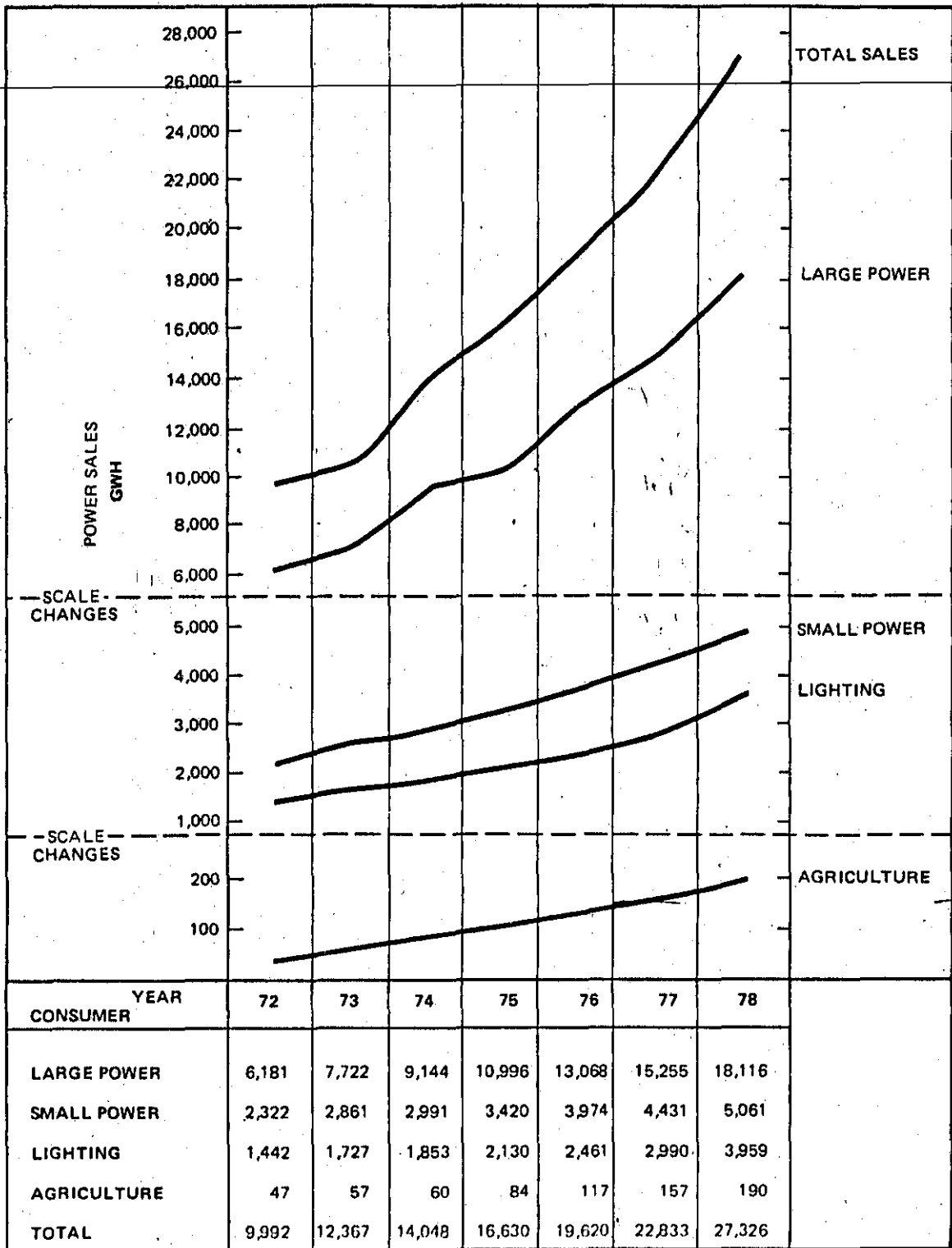
The transmission and distribution system has also had to keep up with the ever increasing load demand. KECO started with 5,237 kilometers of transmission line, primarily 66 kV, with a few 154-kV lines. Distribution was mainly at 3.3 kV, with a few 5.7-kV, 6.6-kV or 11.4-kV lines. The system now consists of 10,990 kilometers of 154-kV, 345-kV, and the original 66-kV lines. Recent emphasis has been placed on 22.9-kV Y distribution systems, with secondary distribution increased from the old 100-200 V to 220-380 V.

### 5.2 CURRENT POWER STATUS

Total energy sales for 1978 reached 27,326 million kilowatt hours. This represented an average annual increase of 18.2 percent during the 1972-1978 period. Table 5.2-1 presents the amount of power consumed for the general types of consumers. The increase in power sales for the period from 1972 through 1978 is shown in Figure 5.2-1.

Table 5.2-1  
POWER SALES FOR 1978

Consumer	kWh	% of Total
Large Power	18,116	66.3
Small Power	5,061	18.5
Lighting	3,959	14.5
Agriculture	190	0.7
Total	27,326	100.0



**KOREA ELECTRIC COMPANY  
KOREA NUCLEAR  
UNITS 7 & 8**

POWER SALES  
1972-1978

Figure 5.2-1

Total system installed capacity at the end of 1978 was 6916 MWe. Thermal plants represent 67.8 percent of the total, with 10.3 percent by hydro, 13.4 percent by internal combustion plants, and 8.5 percent by a nuclear plant. Table 5.2-2 is a tabulation of the operating plants at the end of 1978.

Table 5.2-2  
POWER CAPACITY OF PLANTS IN KOREA (MWe)

Thermal		Hydro		Internal Combustion		Nuclear	
Seoul	412.5	Hwachon	108.0	Wangsibri	39.9	Kori	587
Inchon	1150.0	Chunchon	57.6	Bupyoeng	85.0		
Kyeongin	324.8	Uiam	45.0	Onsudong	32.6		
Busan	330.0	Cheongpyong	79.6	JeJu	8.8		
Gunsan	75.0	Paldang	80.0	Suwongi	5.0		
Honam	560.0	Chilbo	28.8	Yeongweol	200.0		
Jeju	10.0	Uham	2.6	Gunsan	200.0		
Yeosu	500.0	Bosunggang	3.1	Hanrim	13.1		
Yeongweol	100.0	Goesan	2.6	Ulreungdo	0.5		
Samcheog	55.0	Soyanggang	200.0	Ulsan	340.0		
Yeongdong	125.0	Andong	90.0				
Yeongnam	400.0	Chusan	1.4				
Masan	50.0	Nam-Gang	12.6				
Ulsan	600.0	Anheung	0.5				
Total	4692.3	Total	711.8	Total	924.9		587
<b>SUMMARY</b>		<b>MWe</b>	<b>Percent</b>				
Hydro		711.8	10.3				
Thermal		4,692.3	67.8				
Internal Combustion		924.9	13.4				
Nuclear		587.0	8.5				
Total		6,916.0	100.0%				

### 5.3 FORECAST POWER DEMAND

Forecast power demand under KECO's power development program extends ten years, covering 1979 through 1988. KECO continuously reviews and studies its power market to provide a sound basis for long-range planning in a series of five-year plans. This section presents the bases used and the results of the 1977-1981 and 1982-1986 five-year periods.

#### 5.3.1 BASES

- A growth rate of 10.7 percent per year in GNP for the period from 1977 through 1981, as projected by the Korea Development Institute for the fourth five-year economic development plan. A growth rate of 10.0 percent per year for the period from 1982 through 1986, as projected by KECO. *used  
(KDI  
proposed  
(flawed))*
- Rural electrification has almost been completed by 1978. This program was 97.8 percent complete as of the end of 1977.
- Forecasting is based on past power consumption records as well as predicted power demands for three main categories of customers: large power consumers, small power consumers, and lighting (householders, street lighting).
- Large consumers are individually surveyed to determine their specific expansion plans and future power requirements.
- Past growth trends for small power consumers are analyzed, projected, and modified in accordance with known and anticipated pertinent factors that may affect future growth rates. Each major industrial group — textiles, metallurgical, machinery, ceramics, chemical, food, others — is surveyed and analyzed. Overall estimates are further correlated with local consumption trends and export potential. Other factors, such as GNP growth, capital assets, and goals set by various government agencies, are also taken into consideration.
- Future power requirements for lighting customers are determined by analysis of trends in past growth and expected increases in acceptance of electrical appliances. However, increases due to convenience air conditioning have not been considered.
- Total estimated energy requirements for the system are determined by a summation of individual power forecasts for consumers in these major categories. Load characteristics and distribution of demands are also analyzed. System losses are determined for the transmission system by an alternating current network analyzer, and by computer studies that simulate projected system load conditions and power flows.
- The derived average system load requirements are the basis for system planning.

### 5.3.2 FORECAST POWER DEMAND

Results of the load forecast for the period from 1978 through 1988 are presented in Figure 5.3-1. An average annual growth rate of 13.5 percent is anticipated.

Results of the forecast of increased electric power consumption by the types of users are presented in Table 5.3-1. The growth in GNP is forecast to maintain an increase in Large and Small Power users which will account for over 84 percent of total power consumed; however, the increasing prosperity of Korea will account for a greater increase in residential use as more household appliances are brought into common use.

Table 5.3-1  
FORECAST DIVISION OF SALES (% OF TOTAL)

Consumer	1979	1983	1988
Large Power	67.0	67.4	67.9
Small Power	18.4	17.3	16.4
Lighting	14.0	14.7	15.2
Agriculture	0.6	0.5	0.5

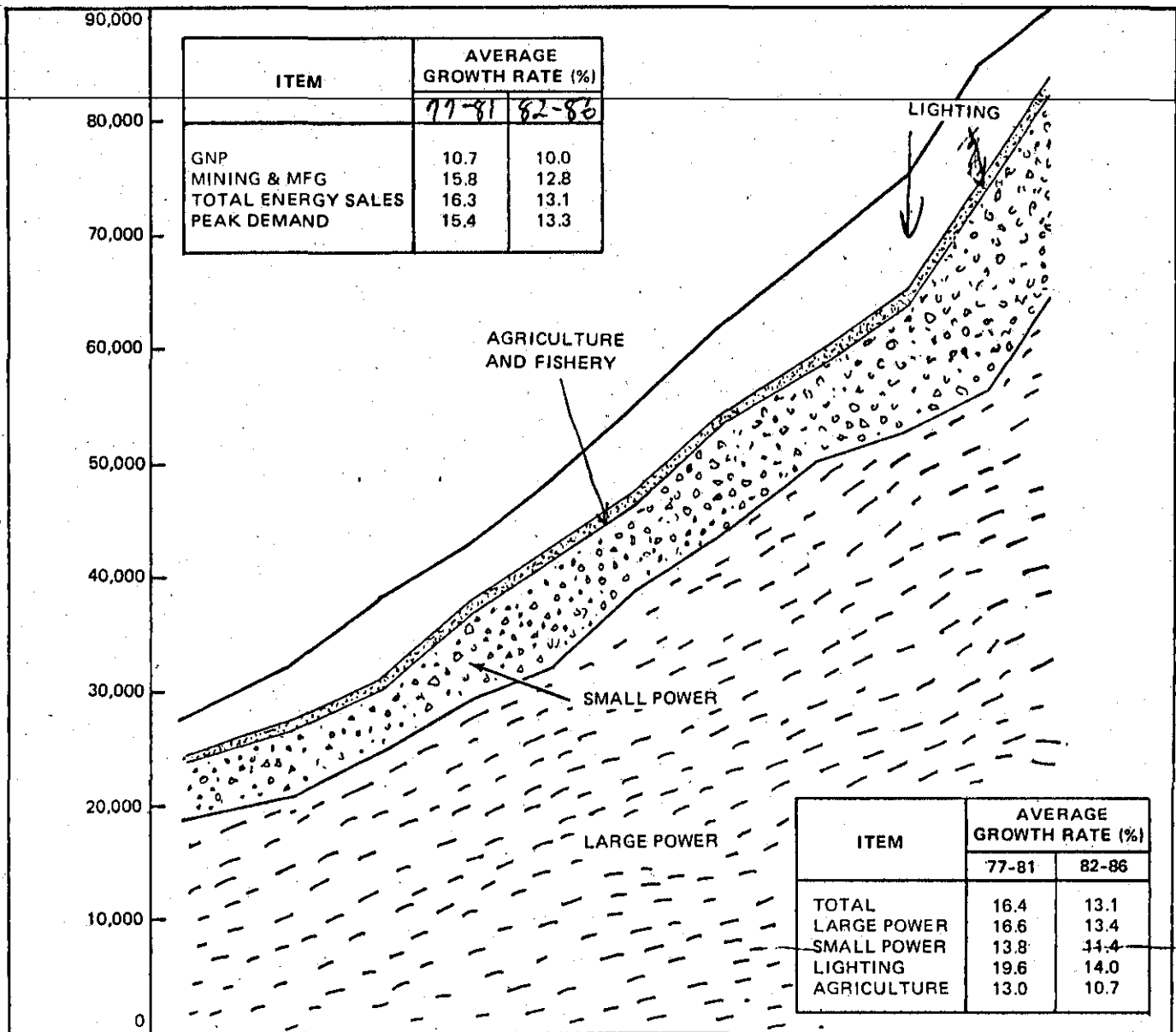
### 5.4 POWER DEVELOPMENT PROGRAM

A summary of the KECO capacity expansion plan is presented in Table 5.4-1. The year-to-year increases in installed capacity have been scheduled to meet forecasted demands with adequate reserves. The 1978 reserve capacity of 7.7 percent is not sufficient. A reserve of 16.1 percent nominal is expected to be achieved in 1979, and will be in the range of 13 to 20 percent through 1988.

Nuclear power will be supplying an increasing share of total installed capacity, rising from 8.5 percent in 1978 to 37.2 percent in 1988. Table 5.4-2 presents the change in contribution of thermal, nuclear, and hydro to total power. The table shows the concentration in the development of hydro and nuclear power plants.

Figure 5.4-1, a bar graph, presents the year-by-year change in total power capacity, as well as the amount supplied by thermal, nuclear, and hydro.

The sequence in which new plants are to be added to KECO's system under the Long-Range Power Development Program is shown in Figure 5.4-2. The figure shows that, in order to meet the long-range load requirements, the development program calls for the construction of 45 facilities over the 1978 to 1988 period. These facilities include the four nuclear power plants currently under construction and six more nuclear units to be initiated and completed by 1988.



YEAR \ ITEM	1978 (ACTUAL)	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
TOTAL SALES (%)	27,326 (19.7)	31,065 (13.7)	36,173 (16.4)	41,820 (15.6)	47,489 (13.6)	53,823 (13.3)	60,880 (13.1)	68,724 (12.9)	77,422 (12.7)	86,531 (11.8)	96,683 (11.7)
LIGHTING	3,959	4,360	5,183	6,022	6,934	7,937	9,037	10,249	12,588	13,078	14,730
AGRICULTURE & FISHERY	190	185	200	215	241	268	296	326	358	391	426
SMALL POWER	5,061	5,700	6,600	7,503	8,374	9,334	10,393	11,561	12,849	14,269	15,833
LARGE POWER	18,116	20,820	24,190	28,080	31,940	36,284	41,154	46,588	52,627	58,793	65,694
PEAK DEMAND (MW)	5,118	5,879	6,773	7,805	8,848	10,023	11,349	12,850	14,547	16,266	18,187



KOREA ELECTRIC COMPANY  
KOREA NUCLEAR  
UNITS 7 & 8

LOAD FORECAST FOR 1978-1988  
(MILLION kWh)

FIGURE 5.3-1

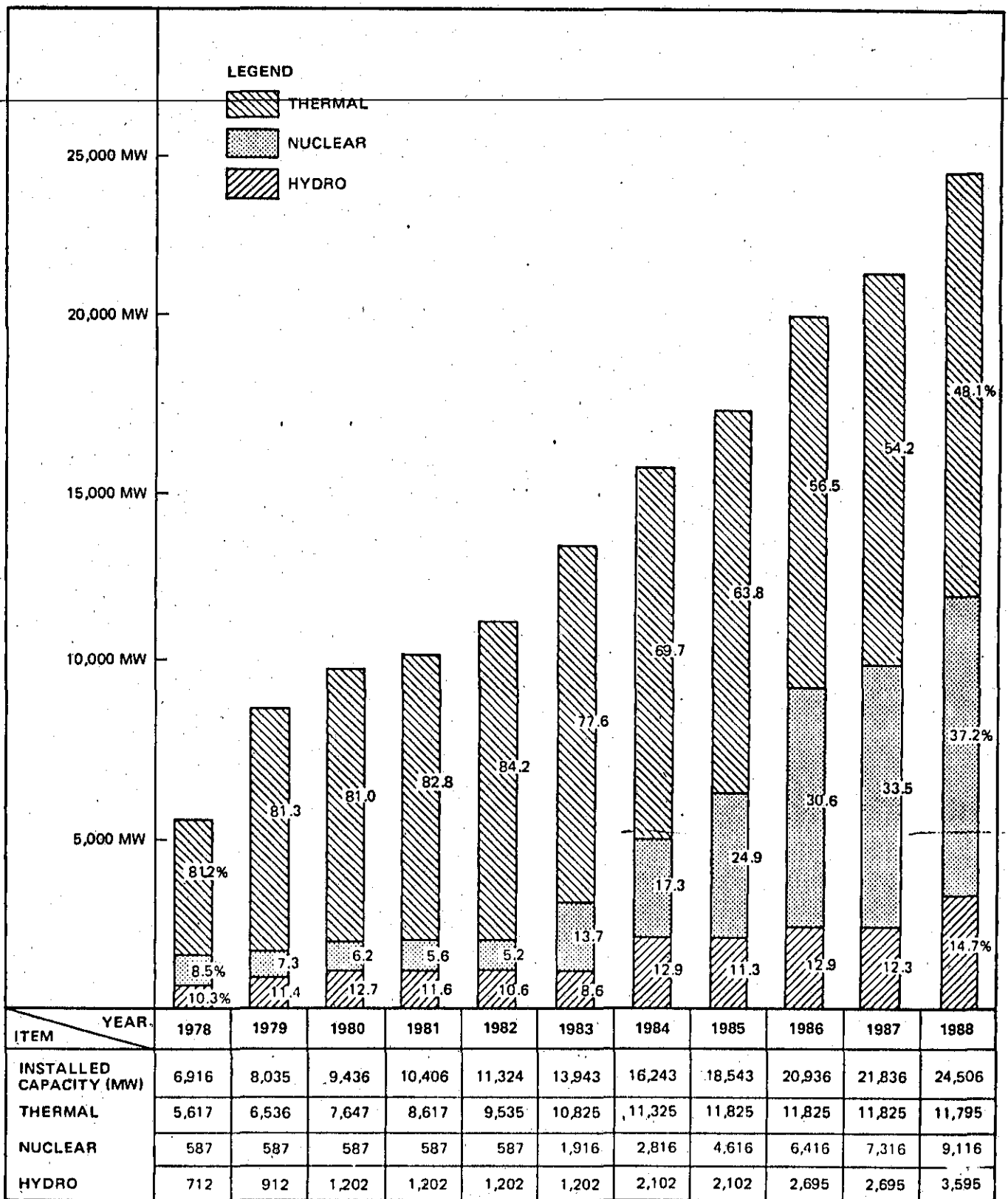
**Table 5.4-1  
LONG-TERM POWER DEVELOPMENT PLAN**


Year	Peak Demand (MW)	Installed Capacity (MW)	Capability (MW)	Reserve	
				(MW)*	(%)
1978	5,118	6,916	5,514	396	7.7
1979	5,879	8,035	6,824	945	16.1
1980	6,773	9,436	8,105	1,332	19.7
1981	7,805	10,406	8,843	1,038	13.3
1982	8,848	11,324	10,172	1,324	15.0
1983	10,023	13,943	11,714	1,691	16.9
1984	11,349	16,243	13,647	2,298	20.2
1985	12,850	18,543	15,470	2,620	20.4
1986	14,547	20,936	17,476	2,929	20.1
1987	16,266	21,836	19,070	2,804	17.2
1988	18,187	24,506	21,401	3,214	17.7

\*Capability minus Peak Demand.

**Table 5.4-2  
INSTALLED CAPACITY OF POWER PLANT-FACILITIES  
(% OF TOTAL)**

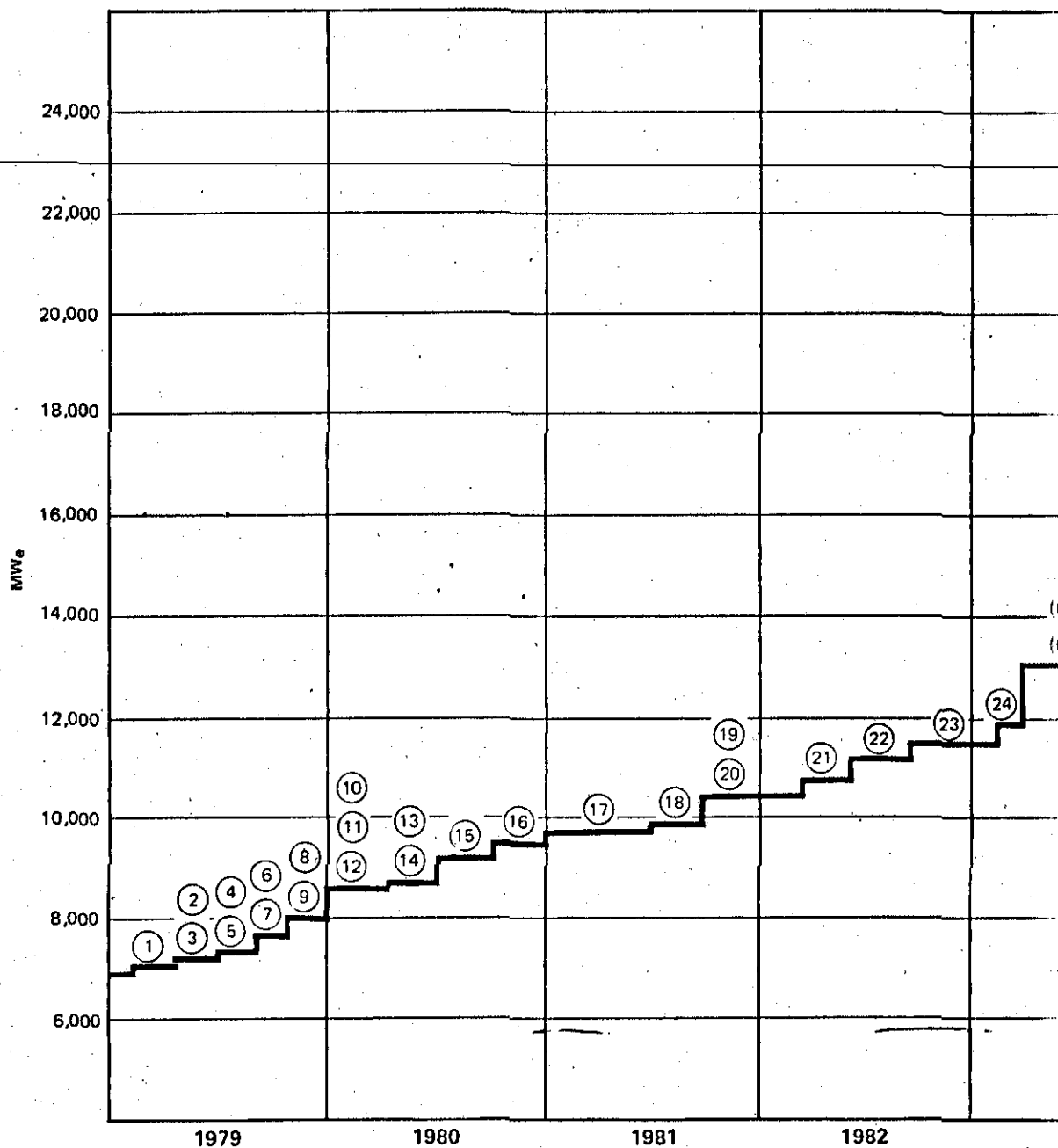
Type	1978	1983	1988
Thermal	81.2	77.6	48.1
Nuclear	8.5	13.8	37.2
Hydro	10.3	8.6	14.7



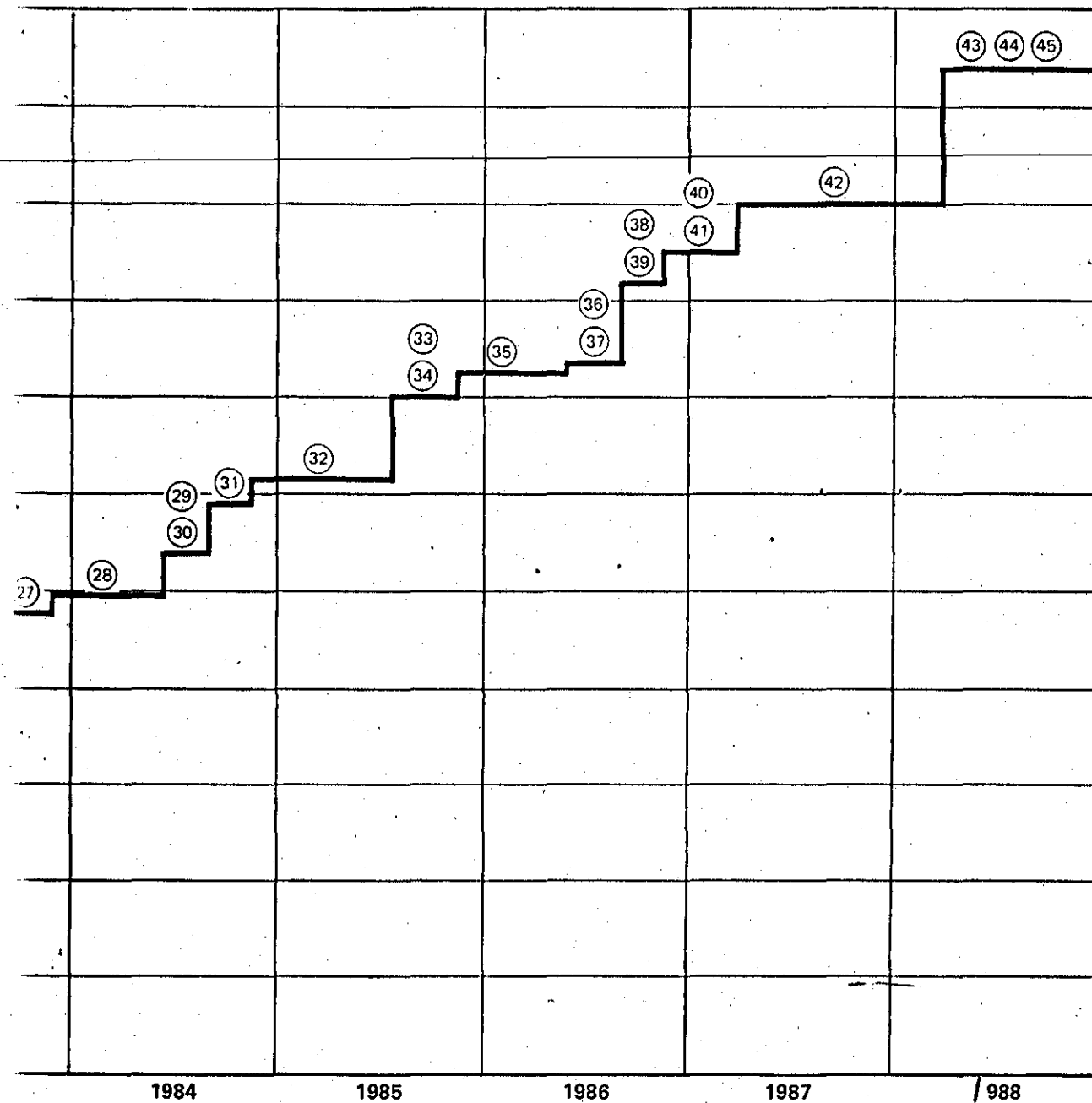
 **KOREA ELECTRIC COMPANY  
KOREA NUCLEAR  
UNITS 7 & 8**

TRENDS OF POWER PLANT FACILITIES  
FIGURE 5.4-1






YEAR (MONTH)	NO.	PLANT NAME	CAPACITY	YEAR (MONTH)	NO.	PLANT NAME	CAPACITY
1979.2	①	YEONG WEOL C/C	100	1980.6	⑭	NAMJEJU THER. NO. 2	100
1979.4	②	GUNSAN C/C	100	1980.9	⑮	ASAN THER. NO. 2	100
1979.6	③	HANRIM DIESEL	10	1980.12	⑯	ULSAN THER. NO. 5	100
1979.7	④	ULSAN C/C	100	1981.6	⑰	ULSAN THER. NO. 6	100
1979.9	⑤	ULREUNGDO DIESEL (1ST)	2	1981.9	⑱	JEJU G/T	200
1979.11	⑥	YEONG DONG THER. NO. 2	200	1981.12	⑲	SEOHAE THER. NO. 1	200
1979.11	⑦	CHEONG PYEONG PUMPED ST. NO. 1	200	1981.12	⑳	ASAN THER. NO. 5	200
1979.12	⑧	ULSAN THER. NO. 4	400	1982.3	㉑	ASAN THER. NO. 6	400
1979.12	⑨	NAMJEJU THER. NO. 1	10	1982.6	㉒	SEOHAE THER. NO. 2	10
1980.3	⑩	ASAN THER. NO. 1	350	1982.8	㉓	SAMCHEONPO THER. NO. 1	350
1980.3	⑪	CHEONG PYEONG PUMPED ST. NO. 2	200	1983.2	㉔	SAMCHEONPO THER. NO. 2	200
1980.3	⑫	ULREUNGDO DIESEL (2ND)	1	1983.4	㉕	WEOLSEONG NUCLEAR	1
1980.6	⑬	DAE CHEONG HYDRO	90	1983.4	㉖	GO JEONG THER. NO. 1	90



YEAR (MONTH)	NO.	PLANT NAME	CAPACITY	YEAR (MONTH)	NO.	PLANT NAME	CAPACITY
1983.10	27	GO JEONG THER. NO. 2	500	1986.12	40	HABCHEON PUMPED ST.	400
1983.12	28	GORI NUCLEAR NO. 2	650	1986.12	41	HABCHEON HYDRO	80
1984.6	29	CHUNGJU HYDRO	300	1987.3	42	NEW NUCLEAR NO. 10	900
1984.6	30	SAMRANGJIN PUMPED ST.	600	1988	43	NEW NUCLEAR NO. 11/12	900x2
1984.9	31	NEW NUCLEAR NO. 5	900	1988	44	TIDAL	400
1984.12	32	ASAN THER. NO. 3	500	1988	45	NEW PUMPED ST. NO. 1	500
1985.9	33	NEW NUCLEAR NO. 6	900				
1985.9	34	NEW NUCLEAR NO. 7	900				
1985.12	35	ASAN THER. NO. 4	500				
1986.6	36	IMHA HYDRO	50				
1986.6	37	HONGCHEON HYDRO	63				
1986.9	38	NEW NUCLEAR NO. 8	900				
1986.9	39	NEW NUCLEAR NO. 9	900				



**KOREA ELECTRIC COMPANY  
KOREA NUCLEAR  
UNITS 7 & 8**

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LONG-RANGE  
POWER DEVELOPMENT PROGRAM

FIGURE 5.4-2

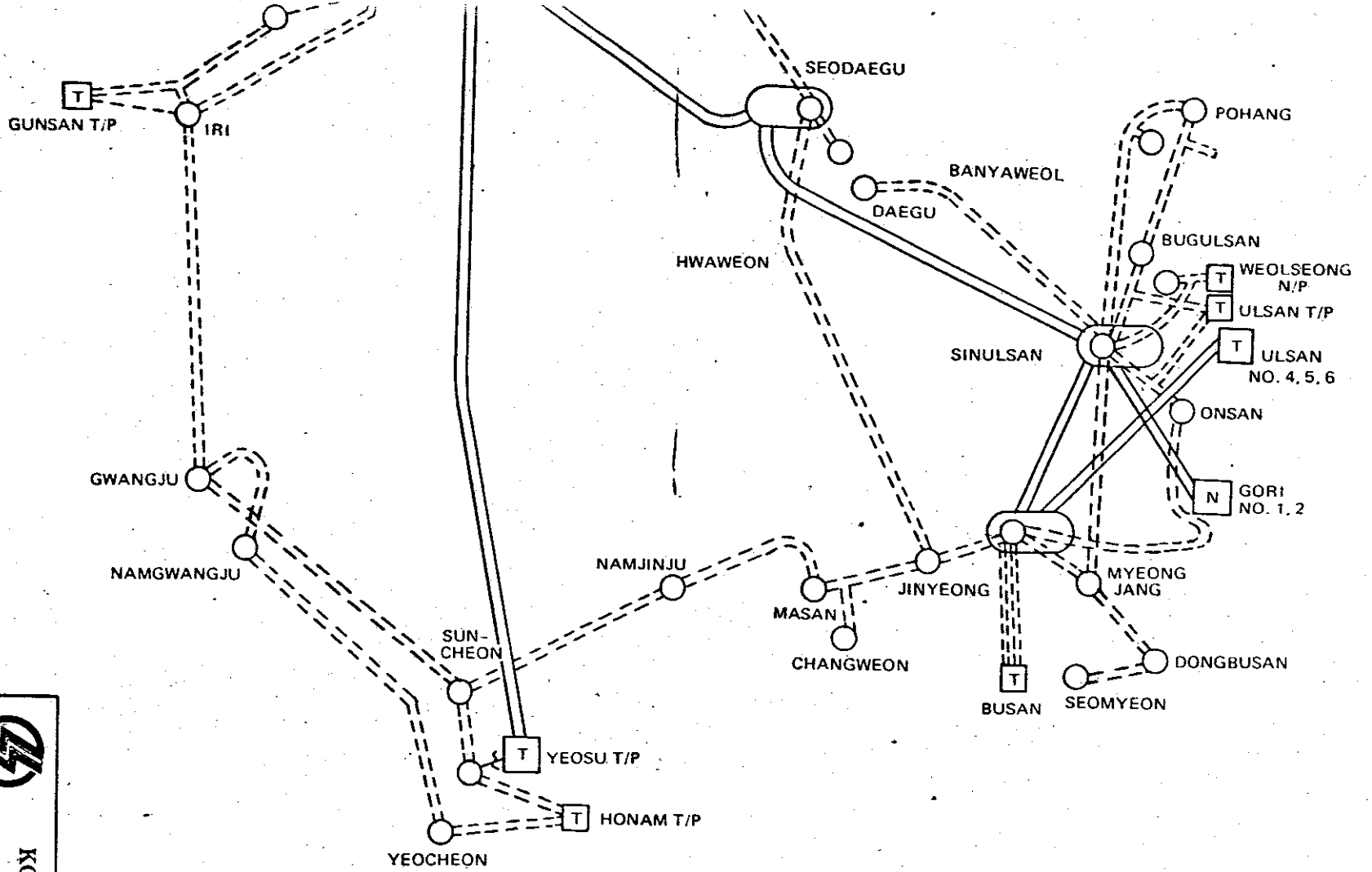
## 5.5 TRANSMISSION AND DISTRIBUTION


Losses on KECO system have been considerably reduced as a result of improvements in the transmission and distribution system, installation of plants and substations near load centers, and intensive service to customers. The loss level of 8.6 percent in 1978 is expected to be reduced to 8.0 percent by 1981, and 7.5 percent by 1986. The following major policies have been adopted to accomplish these goals:

- A. As backbone of the system, the 345-kV system will be expanded to accommodate new generation and loads.
- B. The existing 154-kV transmission system used to serve area loads will continue to be used for system expansion.
- C. Low-voltage transmission system will be standardized at 154 kV and 22.9 kV. The 66-kV system will not be further expanded.
- D. The existing secondary distribution at 220/110 V will be converted to 380/220 V.

The existing system has been analyzed by an alternating current network analyzer and digital computers to determine power flow, short-circuit currents, and stability. Additionally, factors such as reliability and economic constraints have been taken into consideration in reviewing present and planned future expansion.

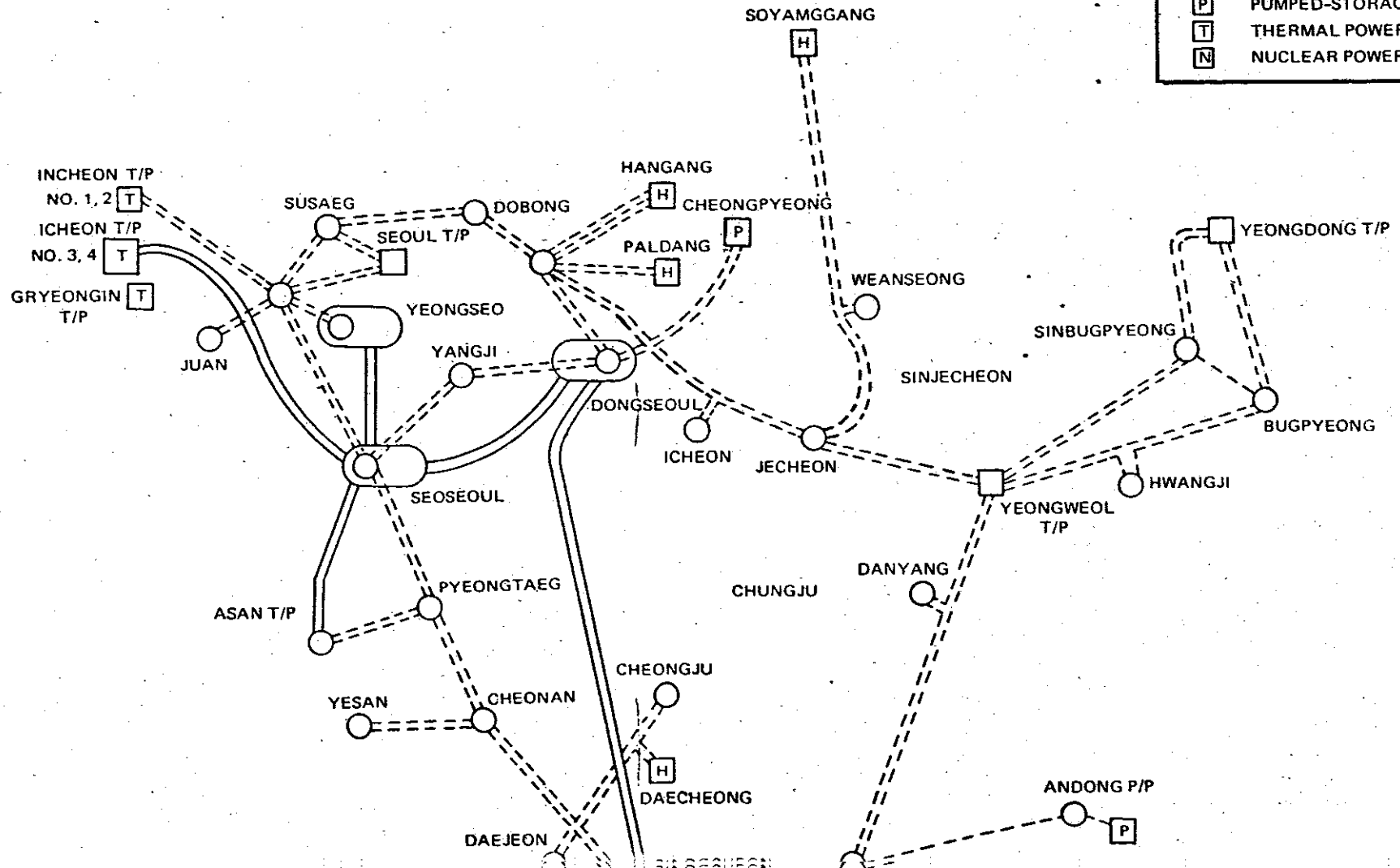
Results of these comprehensive and continuing studies and reviews are shown in the system plans, Figures 5.5-1 (1979), 5.5-2 (1982), and 5.5-3 (1986). Expansion plans for the 345-kV transmission line system are shown in Figure 5.5-4.



	<p><b>KOREA ELECTRIC COMPANY</b>  <b>KOREA NUCLEAR</b>  <b>UNITS 7 &amp; 8</b></p>
<p><b>KOREA ELECTRIC COMPANY</b>  <b>PRIMARY NETWORK IN 1979</b></p>	
<p><b>FIGURE 5.5-1</b></p>	

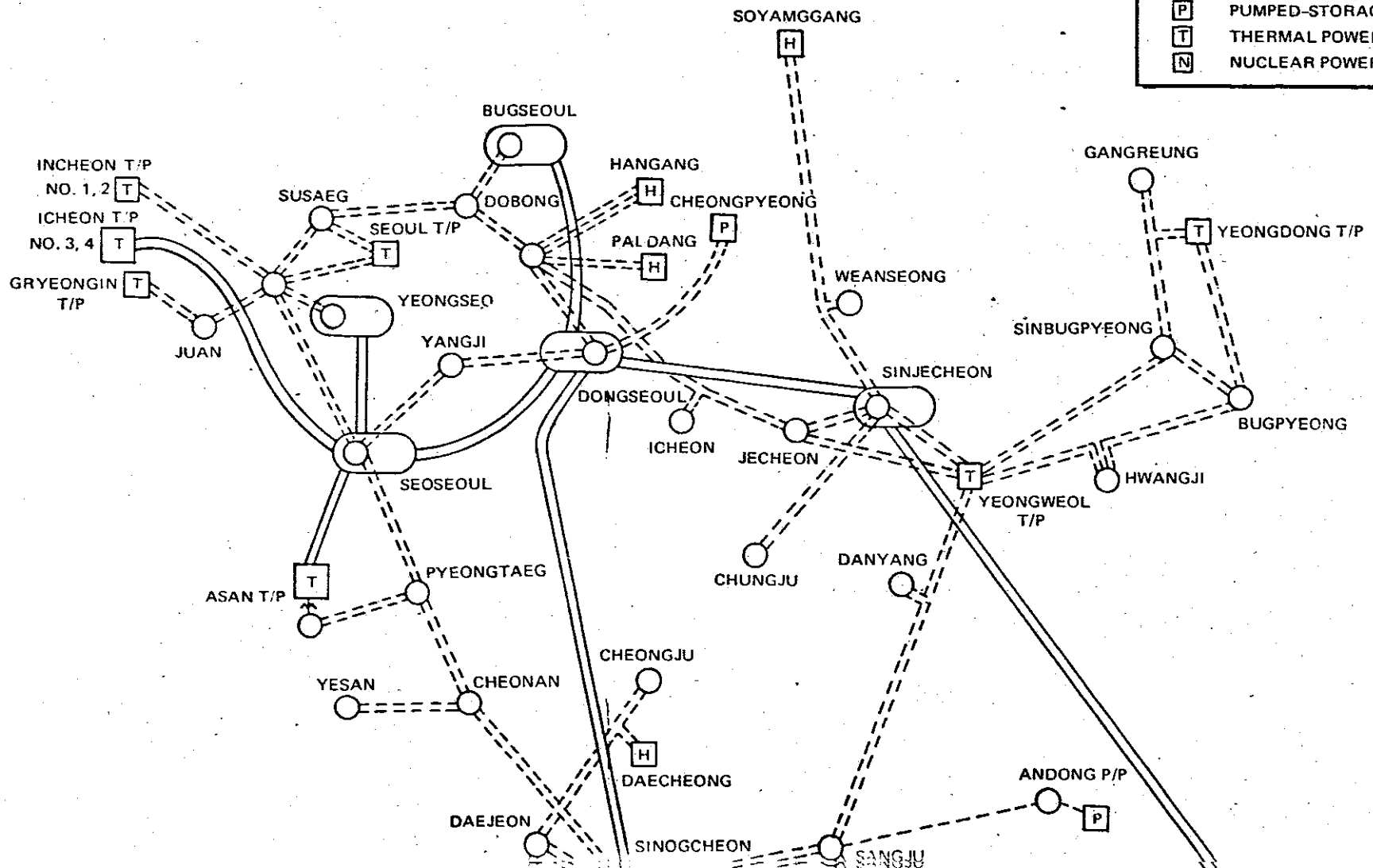
**LEGEND:**

- 345 KV LINE
- - - 145 KV LINE
- - - FUTURE
- 345 KV S/S
- 154 KV S/S
- [H] HYDRO POWER PLANT
- [P] PUMPED-STORAGE PLANT
- [T] THERMAL POWER PLANT
- [N] NUCLEAR POWER PLANT



**LEGEND:**

- 345 KV LINE
- - - 145 KV LINE
- - - FUTURE
- 345 KV S/S
- 154 KV S/S
- [H] HYDRO POWER PLANT
- [P] PUMPED-STORAGE PLANT
- [T] THERMAL POWER PLANT
- [N] NUCLEAR POWER PLANT



SEOHAE T/P

GUNSAN T/P

IRI

GWANGJU

NAMGWANGJU

NAMWEON

SUN-CHEON

YEOSU T/P

HONAM T/P

YEOCHEON

NAMJINJU

MASAN

CHANGWEON

SAMCHEONPO T/P

JINYEONG

MYEONG JANG

MINAN

BUSAN

SEOMYEON

DONGBUSAN

SEODAEGU

BANYAWEOL

DAEGU

HWAWAEON

SINULSAN

BUGULSAN

WEOLSEONG N/P

ULSAN T/P

ULSAN NO. 4, 5, 6

ONSAN

GORI NO. 1, 2

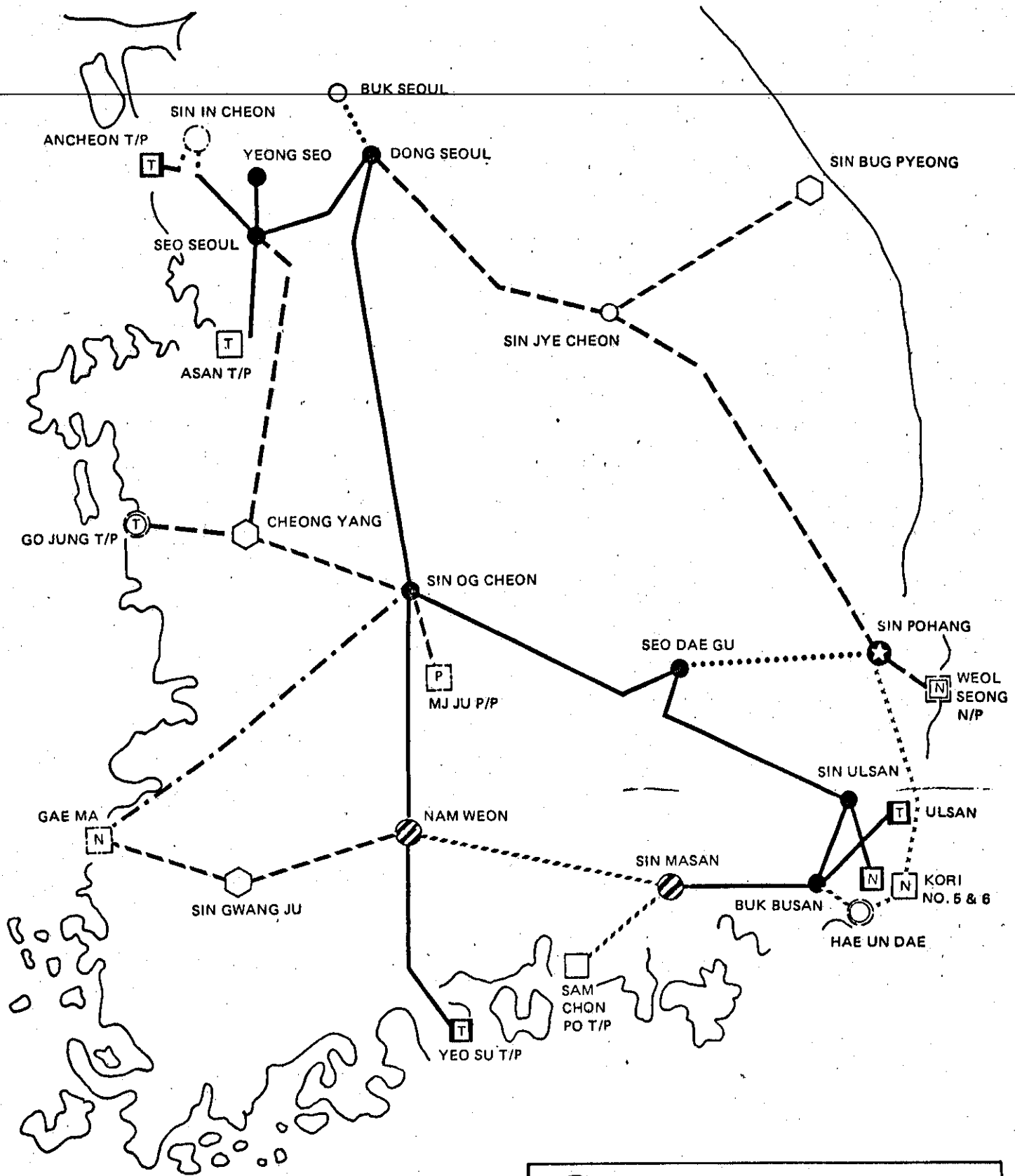
POHANG



KOREA ELECTRIC COMPANY  
KOREA NUCLEAR  
UNITS 7 & 8

KOREA ELECTRIC COMPANY  
PRIMARY NETWORK IN 1982

FIGURE 5.5-2



**LEGEND**

—————	○	□	1983
.....	*****		1984
-----			1985
- · - · -			1986

**KOREA ELECTRIC COMPANY**

**KOREA NUCLEAR**

**UNITS 7 & 8**

**345-kV TRANSMISSION LINE EXPANSION**

**FIGURE 5.5-4**



## 5.6 POWER DEVELOPMENT PROGRAM INVESTMENT

The Long Range Power Development Program outlined in this section will require an investment of 11,466 billion Won (approximately 23.6 billion U.S. dollars) through the 1979 to 1988 period. The Long Range Investment Plan is summarized for each year during the 1979 to 1988 period in Table 5.6-1, which also shows the funding requirements by type of generation facilities, including transmission and distribution, and divides the funding between foreign and domestic requirements. The table indicates that a major portion of the investment will be directed toward the development of nuclear power, with investment in this sector amounting to 6,437 billion Won (approximately 13.3 billion U.S. dollars).

*10 y.  
Investment  
cost of  
program*

*13.3  
---  
23.6 = N.*

Table 5.6-1  
LONG-RANGE INVESTMENT PLAN

Unit: Foreign: \$1,000  
Domestic & Total: million Won

Classification	Financial Source	78	80	81	82	83	84	85	86	87	88	'79-'88
Hydro	Foreign	1,387		6,249	23,685	34,777	42,264	50,088	70,456	56,980	49,076	333,942
	Domestic	13,090	22,346	12,700	26,465	34,607	33,537	42,381	53,803	50,450	45,888	335,264
	Sub-total	13,762	22,346	18,248	37,943	51,471	54,034	66,674	87,973	78,088	69,688	497,224
Thermal	Foreign	194,251	234,814	263,046	206,343	206,360	44,220	14,740		454	75,760	1,239,978
	Domestic	149,448	174,893	109,470	68,224	50,707	11,442	4,304		12,026	42,861	623,375
	Sub-total	243,661	288,778	237,047	168,301	150,792	32,889	11,453		12,246	79,600	1,229,767
Nuclear	Foreign	366,571	445,334	581,260	661,978	836,016	884,404	881,949	866,413	885,297	802,699	7,211,921
	Domestic	150,447	234,190	292,675	308,021	328,381	325,241	263,617	327,391	367,210	342,806	2,939,973
	Sub-total	328,234	450,177	574,586	629,079	733,849	754,177	691,356	747,602	796,579	732,115	6,437,764
Generation Total	Foreign	562,209	680,148	849,555	891,986	1,077,153	970,888	946,777	936,869	942,731	927,525	8,785,841
	Domestic	312,985	431,429	414,845	402,710	413,692	370,220	310,296	381,194	429,686	431,555	3,898,612
	Sub-total	585,657	761,301	826,879	835,323	936,112	841,100	769,483	835,575	886,911	881,404	8,156,745
Transmission & Distribution	Foreign	59,535	25,827	29,584	29,903	37,783	42,655	48,281	54,587	48,981	54,738	431,684
	Domestic	146,533	193,633	223,521	225,903	272,441	307,462	348,024	393,493	328,136	366,699	2,805,845
	Sub-total	175,407	206,062	237,869	240,406	260,771	328,150	371,440	419,968	351,892	393,247	3,015,212
General	Foreign			25,000	30,000	30,000	30,000	30,000	30,000	40,000	40,000	291,184
	Domestic	11,184	25,000	25,000	30,000	30,000	30,000	30,000	30,000	40,000	40,000	291,184
	Sub-total	11,184	25,000	25,000	30,000	30,000	30,000	30,000	30,000	40,000	40,000	291,184
Grand Total	Foreign	621,744	705,775	879,139	921,889	1,114,946	1,013,543	995,058	991,456	991,712	982,263	9,217,525
	Domestic	470,702	650,062	663,366	658,613	716,133	707,682	688,320	804,687	797,822	838,254	6,995,641
	Total	772,248	992,363	1,089,748	1,105,729	1,256,683	1,199,250	1,170,923	1,285,543	1,278,803	1,314,651	11,466,141

## **6.0 KECO FINANCIAL INFORMATION**

### **6.1 GENERAL**

The financial information in this section presents the current financial situation of the Korea Electric Company, provides a record of the financial results of the company over the past five years, and presents financial results of the company's operations projected for years 1979 through 1988.

### **6.2 FINANCIAL STATEMENTS**

Financial statements that present KECO's current financial situation and a comparison for the past five years are set out on pages 6-2 to 6-38. These statements include:

- A. The audited financial statement of KECO for the year ended December 31, 1978 is set out on pages 6-2 to 6-33. This statement includes the notes to the accounts and the auditor's report.
- B. Audited comparative balance sheets and income statements of KECO for the years 1974 to 1978 are set out on pages 6-34 and 6-38. These comparative statements show the rapid growth of KECO's assets, operating revenues, and net income over this period.

### **6.3 FINANCIAL PROJECTIONS**

KECO's Financial Projections for the years 1979 through 1988 have been prepared to reflect KECO's Long Range Development Plan. These projections include projected balance sheets, income, cash flow, and debt service coverage ratio statements. These statements are found on pages 6-39 to 6-43.

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**FINANCIAL STATEMENTS  
1978**

KOREA ELECTRIC COMPANY

---

REPORT ON EXAMINATION OF  
FINANCIAL STATEMENTS  
YEARS ENDED DECEMBER 31, 1978 AND 1977

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# SAN KYONG & COMPANY

TEL: 22-7011 22-6481/3  
CABLE: CERTIFIED SEOUL  
TELEX: SANKCO K27587  
C. P. O. BOX 7144

CERTIFIED PUBLIC ACCOUNTANTS

11TH FLOOR  
DAEWOO CENTER  
286, YANG-DONG CHOONG-KU  
SEOUL, KOREA

February 12, 1979

The Board of Directors  
Korea Electric Company  
Seoul, Korea

We have examined the accompanying balance sheets of Korea Electric Company as of December 31, 1978 and 1977, and the related statements of earnings, changes in stockholders' equity and changes in financial position for the years then ended. Our examination was made in accordance with generally accepted auditing standards and, accordingly, included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

As more fully described in Note 1 to the financial statements, the Company has not reflected its total employees' severance liability in its financial statements. Generally accepted accounting principles require that ₩53,330,549 thousand and ₩45,155,266 thousand be added to the employees' severance liability as of December 31, 1978 and 1977 respectively with corresponding reductions of retained earnings, and reductions in net income of ₩8,175,283 thousand and ₩8,659,750 thousand respectively for the years then ended.

In our opinion, except for the effect of understating employees' severance liability as discussed in the preceding paragraph, the financial statements referred to above present fairly the financial position of Korea Electric Company as of December 31, 1978 and 1977, and the results of its operations and the changes in its stockholders' equity and the changes in its financial position for the years then ended, in conformity with accounting principles generally accepted in the Republic of Korea applied on a consistent basis.

The accompanying supplementary information, though not considered necessary for a fair presentation of the aforementioned financial statements of the Company, is presented herein for analysis purposes. While our examination was made primarily for the purpose of expressing an opinion on the financial

statements, taken as a whole, the supplementary information has been subjected to the same auditing procedures as applied in the examinations of the financial statements and, in our opinion, is fairly stated in all material respects to the financial statements taken as a whole.

A brief summary of our scope of examination and our comments on the loan agreements are presented following the supplementary information.

*San Kyong & Company -*

SAN KYONG & COMPANY  
Certified Public Accountants

(In thous

<u>ASSETS</u>	<u>December 31,</u>	
	<u>1978</u>	<u>1977</u> (Note 12)
Utility plant (Note 1):		
— Generation plant	₩ 888,509,541	₩ 676,445,696
Transmission plant	271,075,898	- 223,296,390
Distribution plant	342,049,312	- 299,038,836
General facilities	9,128,964	9,173,558
Other	9,507,570	-
Construction in progress	642,911,375	- 472,215,275
	<u>2,163,182,660</u>	<u>1,680,169,755</u>
Less accumulated depreciation	469,390,581	412,277,265
	<u>1,693,792,079</u>	<u>1,267,892,490</u>
Investments and other assets:		
Investments (Note 2)	5,853,430	5,192,808
Nonutility property - net (Note 1)	1,575,688	1,494,274
Long-term receivable (Note 3)	20,941,767	19,062,042
	<u>28,370,885</u>	<u>25,749,124</u>
Current assets:		
Cash on hand and in banks	24,901,584	26,015,181
Notes and accounts receivable (Note 4)	58,623,005	41,485,946
Materials and supplies	67,638,744	51,690,491
Advances on purchase contracts	25,312,645	22,440,669
Prepaid expenses	4,790,496	2,509,448
Other current assets	12,037,128	17,916,705
	<u>193,303,602</u>	<u>162,058,440</u>
Deferred accounts (Note 1):		
Development costs	1,395,392	4,518,366
Foreign exchange loss adjustment	29,201,650	8,741,796
Other deferred charges	1,752	23,597
	<u>30,598,794</u>	<u>13,283,759</u>
	<u>₩1,946,065,360</u>	<u>₩1,468,983,813</u>

See notes to fina



TRIC COMPANY

E SHEETS

ands of Won)

<u>STOCKHOLDERS' EQUITY AND LIABILITIES</u>	<u>December 31,</u>	
	<u>1978</u>	<u>1977</u> (Note 12)
Stockholders' equity:		
Common stock (Note 5)	₩ 429,378,732	₩ 399,378,732
Due to Government (Note 6)	68,672,933	20,091,201
Capital surplus	62,389,992	62,370,440
Construction grants (Note 1)	90,568,795	65,502,578
Appropriated retained earnings	17,366,979	13,266,979
Unappropriated retained earnings	59,363,362	66,848,489
	<u>727,740,793</u>	<u>627,458,419</u>
Long-term borrowings and other debt:		
Long-term debt (Note 8)	930,828,359	622,441,492
Bonds (Note 7)	-	19,895,726
Payables on purchase of utility plant	5,621,456	3,783,817
Customers' advances for construction (Note 9)	6,853,891	11,073,789
	<u>943,303,706</u>	<u>657,194,824</u>
Current liabilities:		
Notes and accounts payable	59,984,814	45,541,961
Accrued interest payable	12,134,045	8,462,519
Short-term borrowings	26,005,700	-
Current portion of long-term debt (Notes 7 and 8)	113,633,895	76,707,388
Withholding and accrued taxes	3,097,537	7,151,639
Customers' guarantees	8,118,405	12,463,554
Other current liabilities	9,358,621	8,562,844
	<u>232,333,017</u>	<u>158,889,905</u>
Other credits:		
Employees' severance liability	35,093,674	21,646,011
Special repairs	3,895,878	1,168,016
Auto accidents and disaster self-insurance	3,698,292	2,626,638
	<u>42,687,844</u>	<u>25,440,665</u>
Contingent liability (Note 11)	-	-
	<u>₩1,946,065,360</u>	<u>₩1,468,983,813</u>

cial statements.

KOREA ELECTRIC COMPANY

STATEMENTS OF EARNINGS

(In thousands of Won)

	<u>Year ended December 31,</u>	
	<u>1978</u>	<u>1977</u>
		(Note 12)
Operating revenues:		
Sales of electricity	₩611,572,905	₩503,317,889
Other operating revenues	2,035,268	2,717,088
	<u>613,608,173</u>	<u>506,034,977</u>
Operating expenses:		
Power generation	358,208,683	289,164,682
Electricity purchases	35,630,766	36,103,270
Transmission and distribution	59,530,144	45,943,920
Selling, general and administrative	47,572,834	35,693,424
	<u>500,942,427</u>	<u>406,905,296</u>
Operating profit	112,665,746	99,129,681
Other earnings (deductions):		
Interest income	2,323,475	2,883,887
Government subsidy	1,803,748	2,500,902
Interest expense	(42,624,867)	(25,433,601)
Others - net	(3,278,366)	(2,397,029)
	<u>(41,776,010)</u>	<u>(22,445,841)</u>
Earnings before taxes	70,889,736	76,683,840
<u>Defence and other taxes (Note 10)</u>	<u>6,618,466</u>	<u>8,654,508</u>
Net earnings	<u>₩64,271,270</u>	<u>₩68,029,332</u>

See notes to financial statements.

COMPANYFINANCIAL POSITION

of Won)

Year ended December 31,  
1978                      1977  
(Note 12)

Changes in components of working capital:

(Increase (decrease) in current assets:

Cash on hand and in banks	₩ (1,113,597)	₩ 883,705
Notes and accounts receivable (Note 4)	17,137,059	2,086,095
Materials and supplies	15,948,253	14,665,610
Advances on purchase contracts	2,871,976	(2,490,450)
Prepaid expenses	2,281,048	(200,082)
Other current assets	(5,879,577)	(4,456,824)
	<u>31,245,162</u>	<u>10,488,054</u>

(Increase (decrease) in current liabilities:

Notes and accounts payable	14,442,853	16,113,919
Accrued interest payable	3,671,526	2,696,816
Short-term borrowings	26,005,700	-
Current portion of long-term debt (Notes 7 and 8)	36,926,507	16,069,700
Withholding and accrued taxes	(4,054,102)	(10,127,836)
Customers' guarantees	(4,345,149)	11,113,175
Other current liabilities	795,777	1,082,207
	<u>73,443,112</u>	<u>36,947,981</u>

Increase (decrease) in working capital

₩(42,197,950)                      ₩(26,459,927)

al statements.

KOREA ELECTRIC COMPANY

NOTES TO FINANCIAL STATEMENTS  
Years ended December 31, 1978 and 1977

(In thousands of Won)

1. Summary of significant accounting policies

Basis for the formulation of accounting policies and the preparation of financial statements - The company's business purpose is to promote and provide development of electric energy resources and power generation, transmission and distribution. More than half of the Company's capital has been subscribed by the Government. The Korea Electric Company Act (hereinafter referred to as the KECO Act) provides that: (1) the Government may issue necessary instructions and orders as to electric power generation and supply, development of electric power, conditions for services, etc. and losses incurred in pursuance of such instructions and orders may be compensated for by the Government; (2) costs associated with the facilities for power generation, transmission and distribution may be financed with loans guaranteed by the Government; and (3) the electricity rates may be determined so that the Company may maintain an adequate level of profit.

Under such circumstances, the Company maintains its books of account and prepares its financial statements in accordance with the provisions of the KECO Act and its Accounting Regulations approved by the Minister of Finance. The Accounting Regulations have adopted to a large extent the Uniform System of Accounts established by the Federal Power Commission of the United States.

Utility plant - In compliance with the provisions of the KECO Act in effect prior to the Act amendment in 1976, the Company revalued its utility plant on the first day of each fiscal year. The revaluation surplus from such revaluations has been applied to foreign exchange losses arising from foreign currency loans for the construction of utility plant, revaluation taxes and that portion of dividends due to the Government which falls under the facility investment fund (Note 6). The remaining surplus was then distributed to shareholders as stock dividends. Interest on long-term debt and bonds incurred during construction is capitalized. The details are as follows:

KOREA ELECTRIC COMPANY

NOTES TO FINANCIAL STATEMENTS  
Years ended December 31, 1978 and 1977

(In thousands of Won)

1. Summary of significant accounting policies, continued

	<u>Year ended December 31,</u>	
	<u>1978</u>	<u>1977</u>
Total interest	₩69,878,085	₩48,990,834
Capitalized	<u>30,908,886</u>	<u>23,557,233</u>
Charged to expense	<u>₩38,969,199</u>	<u>₩25,433,601</u>

The transactions of the utility plant revaluation surplus are as follows:

Revaluation surplus (1963-1976)	₩296,269,998
Deductions:	
Off-set with foreign exchange loss	62,755,323
Transfer to due to Government	6,692,894
Payment of revaluation tax	6,392,725
Transfer to common stock	<u>158,485,058</u>
	<u>234,326,000</u>
Balance of revaluation surplus	<u>₩61,943,998</u>

However, under the ammended KECO Act effective from January 1, 1977, the Company is no longer allowed to revalue its plant each year and is prohibited from transferring the above balance of revaluation surplus to common stock as a stock dividend.

The Company computes depreciation on a composite rate by the straight line method over the estimated useful lives of depreciable assets based on the revalued amount. Depreciation expense for 1978 and 1977 amounted to ₩67,706,090 and ₩55,026,637 respectively.

Nonutility property - Nonutility property, not utilized for power generation and supply, is stated at cost and such assets are not subject to the revaluation requirement. However, the Company revalued and depreciated hospital facilities using the same method applied to utility plant. The depreciation expense for 1978 and 1977 was ₩25,411 and ₩42,221 respectively.

KOREA ELECTRIC COMPANY

NOTES TO FINANCIAL STATEMENTS  
Years ended December 31, 1978 and 1977

(In thousands of Won)

1. Summary of significant accounting policies, continued

Investments - Investments in stocks, government securities and others are stated at cost less estimated losses.

Materials and supplies - Fuel for power generation is valued by the monthly total average cost and materials for repairs and construction and others by the moving average cost. Of these materials, certain specific items for construction are valued by historical cost. Inventories stated in the balance sheet at December 31, 1978 and 1977 do not exceed market value.

Deferred charges - Deferred charges are stated at cost less amortization. Amortization is computed on the straight line method over the lives of 3 to 5 years. Amortization for the years of 1978 and 1977 were ₩1,316,048 and ₩1,006,475 respectively.

Translation of foreign currency loans and exchange losses - The Company has translated foreign currency loans into Korean Won using exchange rate effective at the end of each fiscal year. The exchange losses are deferred to the foreign exchange loss adjustment account and amortized on the basis of repayment of loan principal. The changes of this account are as follows:

	<u>Year ended December 31,</u>	
	<u>1978</u>	<u>1977</u>
Balance at beginning	₩ 8,741,796	₩3,168,858
Exchange loss on foreign currency loan	21,639,737	5,947,388
Exchange loss on payables on purchase of utility plant	112,813	147,372
Amortization for the year	<u>(1,292,696)</u>	<u>(521,822)</u>
Balance at ending	<u>₩29,201,650</u>	<u>₩8,741,796</u>

KOREA ELECTRIC COMPANY

NOTES TO FINANCIAL STATEMENTS  
Years ended December 31, 1978 and 1977

(In thousands of Won)

1. Summary of significant accounting policies, continued

Construction grants - According to the Company's accounting regulations, the Company is to record as construction grants 100% of the following funds and materials received to finance construction of utility plant; (a) grants from the Government or public institutions (b) funds, construction materials or other items received from the industrial customers and (c) customers' advances for construction which have become unnecessary for the Company to repay under the terms of contracts (Note 9).

During the years 1969 through 1974, the Company offset the construction grants against utility plant, which is required under the Income Tax Law and was approved by the Government. In recognition of international character of KECO, the Company reversed the offset portion of construction grants to utility plant, which amounted to ₩25,931,067. The additional depreciation of ₩4,934,727 resulting from the reversal of offset construction grants is recorded as retroactive adjustment, thereby resulting in a reduction of previously reported unappropriated retained earnings.

Employees' severance liability - Employees with more than one year of service are entitled to receive a lump-sum payment upon termination of employment. The amount of such benefit is based on the length of service, rate of pay and method of employment termination as prescribed in the Standard Labor Law and compensation policy of the Company. Employees' severance liability at December 31, 1978 and 1977 should be the amount which would sufficiently cover the payment required if all eligible employees voluntarily terminated as of the balance sheet date. However, since the Company provides for employees' severance liability with only budgeted amounts which are approved by the Government, such liability has been understated by ₩53,330,549 and ₩45,155,266 as of December 31, 1978 and 1977. Of the understated amount, ₩45,155,266 and ₩36,495,516 are applicable to prior years, and the remaining ₩8,175,283 and ₩8,659,750 are applicable to the years ended December 31, 1978 and 1977 respectively.

KOREA ELECTRIC COMPANY

NOTES TO FINANCIAL STATEMENTS  
Years ended December 31, 1978 and 1977

(In thousands of Won)

2. Investments

Investments are comprised of the followings:

	<u>December 31,</u>	
	<u>1978</u>	<u>1977</u>
Severance insurance fund	₩4,531,013	₩3,816,960
Dong Hae Electric Co., Ltd.	3,723	3,723
Ho Nam Electric Co., Ltd.	9,674	9,674
Korea Nuclear Engineering Service Inc.	226,410	8,700
Korea Electric Technical Service Company	1,000,000	600,000
Other stocks and securities	82,610	753,751
	<u>₩5,853,430</u>	<u>₩5,192,808</u>

The Company bought 100% of the outstanding shares of stocks and plant of both Dong Hae Electric Co., Ltd. and Ho Nam Electric Co., Ltd. and put both companies in the liquidation process. Most of securities are government bonds and municipal bonds with annual interest rates ranging from 5% to 13.2% per annum. The severance insurance fund represents funds set aside to be paid to the employees upon termination at the stipulated amount.

3. Long-term receivable

Long-term receivable represents the followings:

	<u>December 31,</u>	
	<u>1978</u>	<u>1977</u>
Electrification of rural and fishers' village fund loans	₩16,956,639	₩17,710,637
Installments receivable for sale of land and buildings	3,985,128	1,351,405
	<u>₩20,941,767</u>	<u>₩19,062,042</u>



KOREA ELECTRIC COMPANY

NOTES TO FINANCIAL STATEMENTS  
Years ended December 31, 1978 and 1977

(In thousands of Won)

3. Long-term receivable, continued

Electrification of rural and fishers' village fund loan represents the amount borrowed from the Korea Development Bank as an electrification of rural and fishers' village fund, and subsequently extended to the relevant customers as loans repayable in 30 annual installments after a five-year grace period and at the interest rate of 7.5% per annum. Installments receivable for sale of land and buildings represent the amounts due from those who purchased the land and buildings of the Company on a three to fifteen annual installments term.

4. Notes and accounts receivable

Notes and accounts receivable are stated in the balance sheet as net of allowance for doubtful accounts. The details of notes and accounts receivable are as follows:

	<u>December 31,</u>	
	<u>1978</u>	<u>1977</u>
Accounts receivable - trade		
1976 and prior years	₩ 200,772	₩ 558,031
1977	414,133	38,329,722
1978	54,158,065	-
Accrued interest on delinquent accounts and others	1,089,553	692,691
Allowance for doubtful accounts	(231,373)	(179,683)
	<u>55,531,150</u>	<u>39,400,761</u>
Accounts receivable - non-trade	2,898,905	2,067,899
Notes receivable	92,950	17,286
	<u>₩58,623,005</u>	<u>₩41,485,946</u>

KOREA ELECTRIC COMPANY

NOTES TO FINANCIAL STATEMENTS  
Years ended December 31, 1978 and 1977

(In thousands of Won)

5. Common stock

Authorized common stock is 600,000,000 shares of par value ₩1 thousand. At year-end 1977, the total number of shares outstanding was 399,378,732. During 1978, 30,000,000 shares were issued for cash at par value. Accordingly, the total number of shares of common stock outstanding at December 31, 1978 increased to 429,378,732 shares, of which 352,484,304 shares, or 82.09%, were owned by the Government.

Under the KECO Act, as amended in 1976, the Government has the option to purchase all the outstanding common stock of the Company owned by private investors at par value within 3 years (5 years for certain stocks) commencing January 1, 1977. Also, the dividend payment for those optional period was guaranteed at a rate of 130% of that of time deposit with the maturity of one year.

6. Due to Government

Under the provisions of the KECO Act, dividends applicable to the shares owned by the Government and a certain portion of the fixed assets revaluation surplus should be retained in the due to Government accounts.

7. Bonds

The Company had issued from 1970 to 1976 12.6% to 24% serial bonds redeemable in three annual installments or all the third year after a two-year grace period. Out of the interest rates of the serial bonds, the interest in excess of 7.5% has been reimbursed by the Government. Such bonds may be issued within the limit of five times the Company's common stock outstanding, and are guaranteed by the Government as to redemption.

The details of the total amount of bonds issued and redeemed are as follows:

KOREA ELECTRIC COMPANY

NOTES TO FINANCIAL STATEMENTS  
Years ended December 31, 1978 and 1977

(In thousands of Won)

7. Bonds, continued

	<u>December 31,</u>	
	<u>1978</u>	<u>1977</u>
Total amount issued	₩98,991,000	₩98,991,000
Total amount redeemed	(78,397,379)	(68,925,773)
Balance	20,593,621	30,065,227
Current maturities	(20,593,621)	(10,169,501)
	<u>₩ 0</u>	<u>₩19,895,726</u>

8. Long-term debt

Long-term debt is summarized below:

	<u>December 31, 1978</u>		
	<u>Total</u>	<u>Due within one year</u>	<u>Long-term portion</u>
Domestic currency:			
Korea Development Bank	₩ 390,702,383	₩25,765,279	₩364,937,104
Others	51,633	1,871	49,762
	<u>390,754,016</u>	<u>25,767,150</u>	<u>364,986,866</u>
Foreign currency:			
Korea Development Bank	6,799,523	1,885,471	4,914,052
Korea Exchange Bank	70,040,629	375,365	69,665,264
Borrowings through the Government	155,729,393	6,363,006	149,366,387
Commercial loans	400,545,072	58,649,282	341,895,790
	<u>633,114,617</u>	<u>67,273,124</u>	<u>565,841,493</u>
	<u>₩1,023,868,633</u>	<u>₩93,040,274</u>	<u>₩930,828,359</u>

a) Korea Development Bank loan - The loans, which are not collateralized, consist of the followings:

	<u>Amount</u>
Domestic currency	₩390,702,383
Foreign currency	<u>6,799,523</u>
	<u>₩397,501,906</u>

KOREA ELECTRIC COMPANY

NOTES TO FINANCIAL STATEMENTS  
Years ended December 31, 1978 and 1977

(In thousands of Won)

8. Long-term debt, continued

b) Other borrowings - Other borrowings in domestic currency are comprised of the followings:

	<u>Amount</u>
Jeonju City	₩40,803
Kongju-kun	10,830
	₩51,633

c) Korea Exchange Bank - The loans, which are not collateralized, bear an annual interest rate of Libor plus 1.75%.

d) Borrowings through Government - Borrowings through the Government were obtained from the following 12 credit grantors. These credits are made to the Government and relent to KECO except for EXIM, PEFCO and ADB which are borrowed directly. Repayments of principal and interest of these directly loans are guaranteed by the Government.

	<u>Amount</u>	<u>Annual Interest Rate (%)</u>
U.S.A.:		
AID	₩ 18,545,940	3.5 - 6.0
IBRD	809,661	7.25
EXIM	15,111,117	Libor + 2
PEFCO	15,111,117	Libor + 2
Canada:		
EDC	48,312,098	8.5
Royal	5,658,331	Libor + 2
Japan		
ECOP	1,363,925	5.75
OECF	688,790	3.25
West Germany:		
KFW	11,795,105	4.75 - 5.75
Asia Development Bank	7,568,039	7.5 - 8.75
United Kingdom:		
Hambros	14,396,749	8.5
Lazard	16,368,521	(Libor + 2) - 8.5
	₩155,729,393	

KOREA ELECTRIC COMPANY

NOTES TO FINANCIAL STATEMENTS  
Years ended December 31, 1978 and 1977

(In thousands of Won)

8. Long-term debt, continued

e) Commercial loans - Commercial loans have been made by 38 credit grantors in 8 countries. These loans are guaranteed by the Korea Development Bank or Korea Exchange Bank, both Government owned banks, as to repayment of principal and interest. The amounts of the borrowings by country are as follows:

<u>Country</u>	<u>Amount</u>	<u>Annual Interest Rate (%)</u>
U.S.A.	₩117,416,582	6.0 -(Prime + 2.25)
Japan	105,030,819	5.25 -(Libor + 2)
West Germany	17,395,273	6.0 - 8
United Kingdom	73,933,739	5.5 -(Libor + 2)
France	64,570,523	4.5 -(Libor + 1.75)
Italy	3,013,821	5.75 - 6.0
Panama	4,367,467	Libor + 2
Switzerland	14,816,848	MTNR + 1.75
	<u>₩400,545,072</u>	

9. Customers' advances for construction

Customers' advances for construction represent construction costs paid by customers. Such advances are to be repaid each month in the amount equivalent to 5% of monthly electricity charges to the customers concerned over two to three years. Any balance remaining even after the two or three-year period, is to be credited to the construction grants (Note 1). Under the Electricity Transmission and Distribution Regulation of the Company, however, customers' advances for construction are no longer required from March 15, 1977.

10. Defence and other taxes

Under the provisions of the Law Concerning Restrictions on Tax Exemptions and Reductions, the Company is exempt from income taxes except defence and resident taxes.

KOREA ELECTRIC COMPANY

NOTES TO FINANCIAL STATEMENTS  
Years ended December 31, 1978 and 1977

(In thousands of Won)

11. Contingent liability

The financial statements do not include provisions for 94 compensation claims for electric shock accidents, etc. These claims representing law suits in which the Company is the defendant approximated ₩2,950,460 at December 31, 1978.

12. Reclassification and adjustment of 1977 amounts

Certain amounts in the 1977 financial statements have been reclassified or adjusted (Note 1) to conform to the 1978 presentation.

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SUPPLEMENTARY INFORMATION

se during the year in utility plant accounts are set forth in the following summary:

Balance at Dec. 31, 1977 (Note 12)	During 1978		Balance at Dec. 31, 1978	Accumulated Depreciation	Net
	<u>Addition</u>	<u>Deduction</u>			
464,024,465	W 71,936,894	W 1,829,763	W 534,131,596	W225,899,950	W 308,20
113,218,663	873,987	2,667,845	.111,424,805.	54,386,160	57,00
99,202,568	2,380,911	-	101,583,479	21,945,641	79,60
-	<u>141,369,661</u>	-	<u>141,369,661</u>	<u>5,515,769</u>	<u>135,80</u>
676,445,696	216,561,453	4,497,608	888,509,541	307,747,520	580,70
223,296,390	49,585,271	1,805,763	271,075,898	70,602,724	200,40
299,038,836	59,212,668	16,202,192	342,049,312	87,946,453	254,10
9,173,558	597,656	642,250	9,128,964	3,093,884	6,00
-	9,507,570	-	9,507,570	-	9,50
472,215,275	<u>518,483,571</u>	<u>347,787,471</u>	<u>642,911,375</u>	-	<u>642,90</u>
<u>1,680,169,755</u>	<u>W853,948,189</u>	<u>W370,935,284</u>	<u>W2,163,182,660</u>	<u>W469,390,581</u>	<u>W1,693,70</u>



Construction in progress

The details of this balance are as follows (Thousands of Won):

	December 31,	
	<u>1978</u>	<u>1977</u>
<b>Generating plant:</b>		
Kori construction work	₩123,731,918	₩189,168,729
Ulsan #4,5,6 construction work	64,884,449	30,560,612
Asan T/P #1,2 construction work	57,166,072	12,682,444
Cheongpyong Yang-soo P/P construction work	54,939,034	14,666,939
Young-dong #2 construction work	43,146,294	4,665,741
Wolsung #1 construction work	125,639,581	71,507,608
Miscellaneous	77,555,184	84,857,899
	<u>547,062,532</u>	<u>408,109,972</u>
<b>Transmission and substation:</b>		
345 KV transmission and substation construction work	47,606,004	12,773,443
Miscellaneous	27,814,200	35,643,577
	<u>75,420,204</u>	<u>48,417,020</u>
<b>Distribution:</b>		
All-round office construction work	1,432,691	1,541,256
Voltage conversion and rural electrification work	6,087,765	4,474,383
Miscellaneous	12,604,505	9,185,601
	<u>20,124,961</u>	<u>15,201,240</u>
<b>General facilities:</b>		
All-round office construction work	278,241	387,592
Miscellaneous	25,437	99,451
	<u>303,678</u>	<u>487,043</u>
	<u>₩642,911,375</u>	<u>₩472,215,275</u>

Materials and supplies

Materials and supplies of the Company consisted of (Thousands of Won):

	December 31,	
	<u>1978</u>	<u>1977</u>
Materials for construction and repairs	₩54,114,687	₩38,437,663
<del>Fuel oil for generation</del>	11,006,652	10,154,063
<del>Coal for generation</del>	1,686,588	3,085,739
Medical supplies and other	830,817	13,026
	<u>₩67,638,744</u>	<u>₩51,690,491</u>

3-term debt accounts are summarized as follows (Thousands of Won):

Increase	During 1978		Balance at Dec. 31, 1978	Current Maturities	Long-term Portion
	Exchange Loss (Gain)	Decrease			
1,943,011	W -	W16,337,797	W 390,702,383	W25,765,279	W364,937,104
-	-	2,691	51,633	1,871	49,762
<u>1,943,011</u>	<u>-</u>	<u>16,340,488</u>	<u>390,754,016</u>	<u>25,767,150</u>	<u>364,986,866</u>
-	-	1,886,422	6,799,523	1,885,471	4,914,052
4,705,877	212,825	-	70,040,629	375,365	69,665,264
<u>4,705,877</u>	<u>212,825</u>	<u>1,886,422</u>	<u>76,840,152</u>	<u>2,260,836</u>	<u>74,579,316</u>
10,026,855	6	2,495,515	49,577,835	2,444,542	47,133,293
9,908,076	1,623,169	1,261,000	30,765,270	1,188,250	29,577,020
23,491,764	(3,037,954)	1,616,669	53,970,429	1,616,666	52,353,763
601	385,544	92,337	2,052,715	113,661	1,939,054
117,160	1,571,008	383,792	11,795,105	566,198	11,228,907
20,731	327,889	426,415	7,568,039	433,689	7,134,350
<u>3,565,187</u>	<u>869,662</u>	<u>6,275,728</u>	<u>155,729,393</u>	<u>6,363,006</u>	<u>149,366,387</u>
10,475,275	-	13,251,632	117,416,582	18,614,206	98,802,376
6,837,840	5,657,614	4,187,851	105,030,819	11,719,839	93,310,980
3,064,477	2,242,412	5,996,045	17,395,273	6,005,534	11,389,739
20,880,192	3,368,408	7,694,453	73,933,739	8,030,416	65,903,323
4,447,066	6,866,353	10,283,736	64,570,523	12,396,568	52,173,955
8,547	-	1,341,736	3,013,821	1,336,786	1,677,035
3,185,752	-	-	4,367,467	545,933	3,821,534
12,394,385	2,422,463	-	14,816,848	-	14,816,848
<u>51,293,534</u>	<u>20,557,250</u>	<u>42,755,453</u>	<u>400,545,072</u>	<u>58,649,282</u>	<u>341,895,790</u>
59,564,598	21,639,737	50,917,603	633,114,617	67,273,124	565,841,493
<u>110,507,609</u>	<u>W21,639,737</u>	<u>W67,258,091</u>	<u>W1,023,868,633</u>	<u>W93,040,274</u>	<u>W930,828,359</u>

## Sales of electricity

The following summary shows revenues from sales of electricity  
(Thousands of Won):

	<u>Year ended December 31,</u>	
	<u>1978</u>	<u>1977</u>
Commercial and industrial	₩425,746,793	₩355,366,923
Residential	130,628,299	97,334,139
Public street lighting	1,757,875	1,458,703
Other sales to public authorities	51,465,042	46,336,820
Irrigation	1,974,896	2,821,304
	<u>₩611,572,905</u>	<u>₩503,317,889</u>

## Power generation expenses

The following summary shows the power generation expenses.  
(Thousands of Won):

	<u>Year ended December 31,</u>	
	<u>1978</u>	<u>1977</u>
Operation expenses:		
Supervision	₩ 1,629,982	₩ 385,459
Fuel	283,911,929	236,944,022
Steam	2,029,208	1,575,162
Electricity	2,721,324	1,499,493
Water for power	120,031	30,433
Misc. expenses	7,953,297	5,692,954
Rent	65,981	46,455
	<u>298,431,752</u>	<u>246,173,978</u>
Maintenance expenses:		
Supervision	142,976	149,020
Structures	964,293	682,323
Steam facilities	7,610,055	3,972,766
Electricity facilities	3,811,428	2,147,776
Misc. facilities	1,844,387	1,042,354
Reservoirs, dams and waterways	44,269	40,202
Machinery and tools	1,567,946	516,904
	<u>15,985,354</u>	<u>8,551,345</u>
Depreciation	<u>43,791,577</u>	<u>34,439,359</u>
	<u>₩358,208,683</u>	<u>₩289,164,682</u>

Transmission and distribution expenses

The following summary shows the transmission and distribution expenses (Thousands of Won):

	Year ended December 31,	
	<u>1978</u>	<u>1977</u>
Operation expenses:		
Supervision - operation	₩ 948,434	₩ 549,865
Load dispatching	152,926	230,856
Substation expenses	4,045,655	3,097,436
Overhead line expenses	918,559	552,550
Meter expenses	529,536	327,354
Customer installation expenses	1,742,666	1,413,401
Rent	213,000	224,156
Misc. transmission expenses	2,811,699	2,058,298
Misc. distribution expenses	7,589,094	5,603,705
	<u>18,951,569</u>	<u>14,057,621</u>
Maintenance expenses:		
Supervision - maintenance	233,486	337,783
Structures	652,081	515,976
Overhead lines	7,703,146	6,554,827
Transmission facilities	555,972	511,790
Substation facilities	1,234,361	938,440
Underground lines	87,471	216,450
Line transformers	773,025	624,672
Meters	947,653	1,909,297
Misc. facilities	4,726,747	142,669
	<u>16,913,942</u>	<u>11,751,904</u>
Depreciation	<u>23,664,633</u>	<u>20,134,395</u>
	<u>₩59,530,144</u>	<u>₩45,943,920</u>

Selling, general and administrative expenses

The following summary shows the selling, general and administrative expenses (Thousands of Won):

	Year ended December 31,	
	<u>1978</u>	<u>1977</u>
Salaries	₩ 5,046,244	₩ 3,845,632
Severance pay	22,523,000	16,970,290
Office supplies	2,023,339	1,331,434
Insurance	10,837	7,429
Employees' benefits	1,313,981	823,342
Rent	427,085	277,318
Injuries and damages	487,697	118,224
Equipment maintenance	255,203	179,165
Misc. administrative expenses	1,645,845	117,888
Supervision of sales	1,225,053	613,009
Meter reading expenses	720,662	582,725
Meter adjusting expenses	885,656	570,331
Sales development	586,554	715,855
Collection expenses	4,950,629	3,968,420
Misc. selling expenses	3,576,394	3,810,068
Bad debt	211,770	149,941
Public dues and taxes	116,957	152,995
Depreciation and amortization	<u>1,565,928</u>	<u>1,459,358</u>
	<u>₩47,572,834</u>	<u>₩35,693,424</u>

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A SUMMARY OF SCOPE OF EXAMINATION

## A SUMMARY OF SCOPE OF EXAMINATION

The principal auditing procedures used in the examination of the financial statements of Korea Electric Company for the year ended December 31, 1978 are summarized below. This examination was made in accordance with generally accepted auditing standards and did not contemplate a detailed inspection of each accounting entry or record for the period of the examination but rather such testing as considered necessary in the light of the adequacy of the internal controls and accounting procedures maintained by the Company.

### Cash

Cash on hand was counted at the main office in Seoul, four branch offices and other operating units at various dates subsequent to December 31, 1978. The results of the counts were agreed to the ledger balances. Cash balances on deposits with the provincial banks of the National Agricultural Cooperative Federation, the Company's major depositaries, were confirmed by letters received directly from the selected banks.

### Notes receivable and accounts receivable

We inspected notes receivable on hand and verified collections made subsequent to December 31, 1978 up to audit date. We prepared trial balances of accounts receivable and reconciled the totals with the related general ledger control balances. We selected the customers whose balances exceeded ₩5 million from trial balances of each branch and issued confirmation. The results of confirmation were satisfactory and all differences reported, minor in amounts, were explained satisfactorily and reconciled with the book balance of the Company. We also reviewed the collectibility of delinquent account balances and concluded that possible losses from delinquent accounts would not have a material effect on the operating results and financial position of the Company.

### Investments

We inspected securities on hand and reviewed the valuation methods adopted by the Company and traced related entries covering the additions and disposals of the securities. We tested income earned and dividends received on selected investment securities.

### Materials and supplies

We observed the annual physical inventory taking on June 30, 1978 and reviewed the result and the procedures of the physical inventory counts performed by the Company. In addition, we tested the transactions from June 30, 1978 to December 31, 1978 on a random basis to the extent as considered necessary in the circumstances during our audit period. We made sufficient tests of pricing to satisfy ourselves that the inventories are stated at the lower of moving average cost or market.

### Utility plant

Additions to utility plant accounts during the year were tested by reference to invoices, contracts and other supporting data to see that they represents amounts properly added to the accounts. We reviewed the capitalization policy adopted by the Company and made sufficient tests of entries covering utility plant transactions to see that they are properly classified. We tested the calculation of depreciation for the year.

### Deferred accounts

We reviewed the basis to defer and amortize and tested accounting records and supporting data for the transactions of these accounts. We tested amortization for the year.

### Notes and accounts payable

The principal auditing procedures with respect to notes and accounts payable was direct confirmation with the customers. We also reviewed cash and deposit disbursements made during January 1979 to determine if any significant liabilities existed at December 31, 1978, other than those included in the balance sheet at that date.

### Accrued and other liabilities

We tested interest payable by referring to loan agreements and by confirming directly to respective lenders. We made tests of taxes, including taxes payable by referring to related tax laws and supporting documents. We also tested, as appropriate, the other elements included in other liabilities accounts.



### Borrowings

The outstanding balance of borrowings was confirmed by letters received directly from selected lenders. We examined the appropriate loan agreements and other loan documents under which the Company has borrowed. We reviewed the calculations of won equivalents of foreign currency amounts by applying the prevailing respective exchange rates at December 31, 1978.

### Stockholders' equity

Transactions in the stockholders' equity accounts were reviewed by reference to the detail records of the Company and by reference to minutes of meetings of the Company's board of directors and stockholders. The capital amount and the number of shares of common stock issued and outstanding at balance sheet date was confirmed by registration certificate issued by Seoul Civil Court. We also reviewed the transactions of reserve accounts to see that capital surplus and other accounts were classified properly.

### Income and expenses

Limited tests were made on individual transactions to determine that income and expenses were being properly determined having regard to the existing system of internal control. In addition, certain overall tests of reasonableness of recording were performed.

### Contingent liabilities

We reviewed the minutes of the Company's board of directors and stockholders meetings and long-term contracts and discussed with management to see if there were any contingent liabilities unknown to us.

### Subsequent events

We reviewed the minutes of the Company's board of directors and stockholders meetings held from the balance sheet date to the date of our examination and discussed with management of the Company to see any events or transactions occurred since the balance sheet date which would have a material effect upon the financial statements at that date or for the period then ended.

COMMENTS CONCERNING LOAN AGREEMENTS

We examined the covenant and warranty provisions of AID, BOA, ADB, IBRD and EXIM Bank loan agreements to determine whether the Company has complied with the specific covenants and warranty provisions of the agreements.

The foregoing examination did not bring to our attention any matter which caused us to believe that the Company has failed to comply with the various covenant and warranty provisions and we verified from the records of the Company that the loans are being properly administered in accordance with the related provisions of the respective loan agreements.

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**COMPARATIVE FINANCIAL STATEMENTS**  
**1974 to 1978**

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**KOREA ELECTRIC COMPANY**

**COMPARATIVE FINANCIAL STATEMENTS**  
**1974 to 1978.**

**COMPARATIVE BALANCE SHEETS (AUDITED)**

**ASSETS**

(In millions of won)

Year ending December 31	1974	1975	1976	1977	1978
<b>Utility Plant</b>	540,172	737,050	931,105	1,267,892	1,693,791
Generation plant	311,109	419,412	577,415	676,446	888,510
Transmission plant	82,413	117,304	175,740	223,296	271,076
Distribution plant	124,627	170,708	232,644	299,039	342,049
General facilities	5,394	6,476	8,687	9,173	18,636
Construction in progress	132,119	180,950	296,658	472,215	642,911
Less accumulated depreciation	115,490	157,800	360,039	412,277	469,391
<b>Investments and Other Assets</b>	29,257	23,645	25,383	25,749	28,371
Investments	9,184	4,059	4,326	5,193	5,853
Non-utility property – net	431	464	2,627	1,494	1,576
Long-term receivable	19,642	19,122	18,430	19,062	20,942
<b>Current Assets</b>	60,448	90,473	151,570	162,058	193,304
Cash on hand and in banks	5,482	11,952	25,131	26,015	24,902
Marketable securities at cost			20,000	10,000	
Notes and accounts receivable	15,858	26,043	39,400	41,486	58,623
Materials and supplies	26,078	33,768	37,025	51,690	67,639
Advances on purchase contracts	10,285	12,924	24,931	22,441	25,313
Prepaid expenses	1,788	2,190	2,709	2,509	4,790
Other current assets	957	3,596	2,374	7,917	12,037
<b>Deferred Accounts</b>	33,936	(734)	4,508	13,284	30,599
Development costs	818	155	328	4,518	1,395
Foreign exchange loss (profit)	30,882	(2,215)	3,169	8,742	29,202
Other deferred charges	2,236	1,326	1,011	24	2
<b>Total Assets</b>	663,813	850,434	1,112,566	1,468,984	1,946,065

**COMPARATIVE BALANCE SHEETS (AUDITED)**

**ASSETS**  
(In millions of won)

Year ending December 31	1974	1975	1976	1977	1978
Stockholders' Equity	164,894	280,617	478,661	627,458	727,740
Common stock	93,414	165,249	331,379	399,379	429,378
Due to Government	16,198	18,690	20,091	20,091	68,673
Capital surplus	37,517	61,493	62,352	62,370	62,390
Construction grant	5,867	15,508	23,275	65,503	90,569
Retained earnings	11,898	19,677	41,564	80,115	76,730
Long-term borrowings and other debt	377,228	433,730	495,454	657,195	943,304
Long-term debt	332,788	389,225	449,434	622,441	930,828
Bonds	33,466	31,635	29,496	19,896	—
Payable on purchase of utility plant	3,664	4,228	4,526	3,784	5,621
Customers' advances for construction	7,310	8,642	11,998	11,074	6,854
Current liabilities	113,550	124,570	121,942	158,890	232,333
Notes and accounts payable	37,046	34,848	29,428	45,542	59,985
Accrued liabilities	5,488	5,582	5,766	8,462	12,134
Long-term debt due within one year	51,474	60,522	60,638	76,707	113,634
Withholding and accrued taxes	14,080	17,322	17,279	7,152	3,098
Customers' guarantees	431	1,313	1,350	12,464	8,118
Other current liabilities	5,031	4,983	7,481	8,563	35,364
Reserve accounts	8,141	11,517	16,509	25,441	42,688
Employees' severance payment	7,284	10,455	11,914	21,646	35,094
Special repair			3,205	1,168	3,896
Auto accidents and fire self-insurance	857	1,062	1,390	2,627	3,698
Contingent liabilities					
<b>Total Liabilities</b>	<b>663,813</b>	<b>850,434</b>	<b>1,112,566</b>	<b>1,468,984</b>	<b>1,946,065</b>

**COMPARATIVE STATEMENT OF INCOME (AUDITED)**  
(In millions of won)

Year ending December 31	1974	1975	1976	1977	1978
Operating revenues	149,799	286,897	385,809	506,035	613,608
Sales of electricity	149,188	285,748	384,328	503,318	611,573
Other operating revenues	611	1,149	1,481	2,717	2,035
Operating expenses	146,012	250,099	330,622	406,905	500,942
Power generation	118,918	181,463	243,221	289,165	358,208
Electricity purchased	16,176	29,249	33,344	36,103	35,631
Transmission and distribution	11,161	22,992	34,807	45,944	59,530
Selling, general, and administrative	(243)	16,395	19,250	35,693	47,573
Operating profit	3,787	36,798	55,187	99,130	112,666
Other income (deduction)	547	(21,361)	(22,528)	(22,446)	(41,776)
Interest and dividend income	410	183	873	2,884	2,323
Government subsidy	21,448	2,981	2,991	2,501	1,804
Interest expense	(19,988)	(24,192)	(25,065)	(25,434)	(42,625)
Other — net	(698)	(333)	(1,327)	(2,397)	(3,278)
Income before taxes	4,334	15,437	32,659	76,684	70,890
Income taxes		2,216	2,934	8,655	6,619
Net income	4,334	13,221	29,725	68,029	64,271

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**FINANCIAL PROJECTIONS**  
**1979 to 1988**



**KOREA ELECTRIC COMPANY**  
**Projected Income Statements 1979 – 1988**

(Unit: Million Won)

As of 31 December	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Energy Generated (GWH)	35,922	41,611	48,158	54,801	62,107	70,172	79,126	89,042	99,411	110,954
Energy Sold (GWH)	31,065	36,173	41,820	47,489	53,823	60,880	68,724	77,422	86,531	96,683
Energy Sold to Energy Generate (%)	86.48	86.93	86.84	86.66	86.66	86.76	86.85	86.95	87.04	87.14
Average Revenue per kWh (Won)	29.36	37.96	39.79	41.73	41.68	41.62	41.56	41.51	41.51	41.51
Operating Revenues:										
Sale of Electricity	911,914	1,372,980	1,664,018	1,981,799	2,243,287	2,533,885	2,856,475	3,213,901	3,592,054	4,012,844
Other Revenues	5,012	5,254	5,993	6,724	7,531	8,419	9,396	10,466	11,574	12,796
Total Operating Revenues	916,926	1,378,234	1,670,011	1,988,523	2,250,818	2,542,304	2,865,871	3,224,367	3,603,628	4,025,641
Operating Expenses:										
Generation	517,714	740,313	860,663	967,748	1,012,955	1,048,208	1,137,888	1,193,719	1,248,304	1,348,302
Transmission	15,578	18,144	20,783	23,517	26,396	29,560	33,087	36,999	41,143	45,534
Distribution	44,152	51,015	57,823	64,745	72,150	80,289	89,321	99,301	109,770	121,023
Administration and General	62,787	71,904	90,115	69,336	76,632	84,520	93,219	102,727	112,396	123,083
Depreciation	98,784	123,407	151,160	181,425	228,953	284,559	345,056	413,656	469,705	532,951
Total Operating Expenses	739,015	1,004,783	1,180,544	1,306,770	1,417,085	1,527,137	1,698,572	1,846,401	1,981,317	2,170,893
(Won/kWh Sold)	23.79	27.76	28.23	27.52	26.33	25.08	24.72	23.85	22.90	22.45
Net Profit Before Interest	177,911	373,452	489,467	681,753	833,733	1,015,167	1,167,300	1,377,966	1,622,312	1,854,748
Less: Interest Paid	65,587	78,479	117,142	151,595	166,245	187,963	179,884	220,305	243,377	222,979
Net Profit Before Tax	112,324	294,973	372,325	530,158	667,488	827,204	987,416	1,157,661	1,378,935	1,631,769
Average Net Fixed Assets in Operation (Won)	1,361,281	1,704,936	2,068,749	2,460,449	3,249,483	4,236,579	5,310,493	6,563,132	7,462,359	8,450,131
Ratios:										
Operation Ratio A/(%)	80.60	72.90	70.69	65.72	62.96	60.07	59.27	57.26	54.98	53.93
Rate of Return B/(%)	13.07	21.90	23.66	27.71	25.66	23.96	21.98	21.00	21.74	21.95

Notes:

- A/ Ratio of Total Operating Expenses to Total Operating Revenues  
 B/ Ratio of Net Profit Before Interest to Average Net Fixed Assets in Operation  
 Columns May Not Add Exactly Due to Rounding

**KOREA ELECTRIC COMPANY**  
**Projected Cash Flow 1979 – 1988**

(Unit: Million Won)

As of 31 December	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
<b>SOURCE OF FUNDS</b>										
Net Income before Taxes and Interest	177,911	373,452	489,467	681,753	833,733	1,015,167	1,167,300	1,377,966	1,622,312	1,854,748
Depreciation	98,784	123,407	151,160	181,425	228,953	284,559	345,056	413,656	469,705	532,951
• Total Cash Generated from Operations	276,695	496,859	640,627	863,178	1,062,686	1,299,726	1,512,356	1,791,622	2,092,017	2,387,699
• Customer's Advances/Contr.	15,906	15,352	16,128	19,730	20,229	20,617	21,504	22,446	24,386	24,275
• Borrowings	687,299	752,964	703,772	639,277	725,420	502,616	482,603	480,856	480,980	476,398
Foreign Currency	301,546	342,301	426,382	447,116	540,749	491,569	482,603	480,856	480,980	476,398
Domestic Borrowings	385,753	410,663	277,390	192,161	184,671	11,047	0	0	0	0
• Stock Issue	28,700	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
• Government Subsidies	503	—	—	—	—	—	—	—	—	—
• Others	126,272	69,974	88,060	66,357	78,677	109,850	141,008	190,161	240,539	280,468
<b>TOTAL SOURCES</b>	<b>1,135,375</b>	<b>1,385,148</b>	<b>1,498,587</b>	<b>1,638,543</b>	<b>1,937,012</b>	<b>1,982,809</b>	<b>2,207,471</b>	<b>2,535,085</b>	<b>2,887,922</b>	<b>3,218,840</b>
<b>APPLICATION OF FUNDS</b>										
• Capital Expenditure for Const.	795,325	1,003,100	1,109,379	1,124,101	1,314,597	1,298,450	1,324,500	1,513,952	1,502,466	1,543,797
Generation	585,657	761,301	826,879	835,323	936,112	841,100	769,483	835,575	886,911	881,404
T/D	175,407	206,062	237,869	240,406	290,771	328,150	371,440	419,968	351,892	393,247
Other Facilities	11,184	25,000	25,000	30,000	30,000	30,000	30,000	30,000	40,000	40,000
Nuclear Fuel	23,077	10,737	19,631	18,372	57,714	99,200	153,577	228,409	223,663	229,146
• Total Interest and Amortization (Debt Service)	200,646	210,460	329,576	461,793	571,472	631,562	709,648	761,635	745,839	707,120
Interest	65,587	78,479	117,142	151,595	166,245	187,963	179,884	220,305	243,377	222,979
Foreign Loans	22,290	22,752	29,405	48,395	60,759	83,555	95,704	153,238	194,499	189,255
Domestic Loans	43,297	55,727	87,737	103,200	105,486	104,408	84,179	67,067	48,878	33,724
Amortization	135,059	131,981	212,434	310,198	405,227	443,599	529,764	541,330	502,462	484,141
Foreign Loans	61,201	91,843	90,418	105,988	169,164	210,935	272,470	331,285	374,790	398,684
Domestic Loans	73,858	40,138	122,016	204,210	236,063	232,664	257,295	210,045	127,671	85,458
• Defense Tax	11,232	29,497	—	—	—	—	—	—	—	—
• Dividend (Non-Government Portion)	18,593	5,087	2,544	—	—	—	—	—	—	—
• Government Subsidies	503	—	—	—	—	—	—	—	—	—
• Others	109,076	137,003	57,088	52,648	50,943	52,798	173,322	259,499	639,618	967,922
<b>TOTAL APPLICATION</b>	<b>1,135,375</b>	<b>1,385,148</b>	<b>1,498,587</b>	<b>1,638,543</b>	<b>1,937,012</b>	<b>1,982,809</b>	<b>2,207,471</b>	<b>2,535,085</b>	<b>2,887,922</b>	<b>3,218,840</b>

Note: Columns May Not Add Exactly Due To Rounding

## DEBT SERVICE COVERAGE RATIO

(UNIT: Million Won)

Classification	Year	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Net Income After Tax		101,092	265,476	372,325	530,158	667,488	827,204	987,416	1,157,661	1,378,935	1,631,769
Interest Charge		65,587	78,478	117,142	151,595	166,245	187,963	179,884	220,305	243,377	222,979
Depreciation		98,784	123,407	151,160	181,425	228,953	284,559	345,056	413,656	469,705	532,951
Subtotal (A)		265,463	467,361	640,627	863,177	1,062,686	1,299,727	1,512,356	1,791,622	2,092,016	2,387,699
Principal Reimbursement		135,059	131,981	212,434	310,198	405,227	443,599	529,764	541,330	502,462	484,141
Interest for Construction		61,204	105,930	134,922	168,681	178,457	182,502	184,367	131,046	97,941	114,462
Interest Charge		65,587	78,479	117,142	151,595	166,245	187,963	179,884	220,305	243,377	222,979
Subtotal (B)		261,849	316,390	464,497	630,474	749,929	814,063	894,015	892,680	843,779	821,582
Debt Service Coverage R, (A/B)		1.0138	1.4772	1.3792	1.3691	1.4170	1.5966	1.6916	2.0070	2.4793	2.9062

Note. Columns May Not Add Exactly Due To Rounding

## APPENDIX A

### PROJECT DESCRIPTION

Cost evaluations and future load forecasts have resulted in selection of two PWR type nuclear power plants, each to have a nominal electric output of 950 MW. One plant is scheduled for completion in 1986, to be followed by the second plant in 1987. The plants which will be located at Gyaema-Ri on the southwestern coast of Korea, have been designated Nuclear Plants 7 and 8.

#### A.1 SITE DESCRIPTION

##### A.1.1 GENERAL

Investigation of potential nuclear power plant sites in Korea has continued since 1968. Sixteen sites have been studied with respect to accessibility, topography, geology, seismology, meteorology, hydrology, demography, land usage, physiography, and oceanography. The investigation found the most promising southwestern site to be Gyaema-Ri. Further studies to be conducted are discussed in this section.

##### A.1.2 SITE SELECTION

Siting studies performed to date have reduced the number of potential nuclear power plant sites to two: Gyaema-Ri and Bugu-Ri. The locations of these sites are shown in Figure A.1-1. The Gyaema-Ri site appears to be the most suitable of those studied.

The Gyaema-Ri site is on the southwestern coast of the Republic of Korea. Gyaema is approximately 60 kilometers northwest of Gwanju City. Latitude and longitude of the site are 35° 25'N and 129° 25'E, respectively.

##### A.1.3 ACCESSIBILITY

The nearest airport from the site is the Gwangju Airport, at Gwangju, 60 km southeast of the site.

The sea area adjacent to the Gyaema site is open ocean. The site will have docking facilities that can accommodate barges to 3000 tons capacity. It is anticipated that major equipment will be delivered by barge.

## APPENDIX A

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##### A.1.2 SITE SELECTION

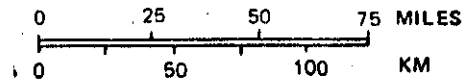
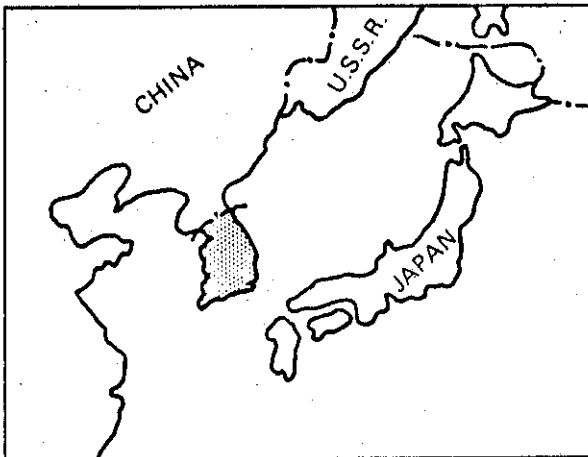
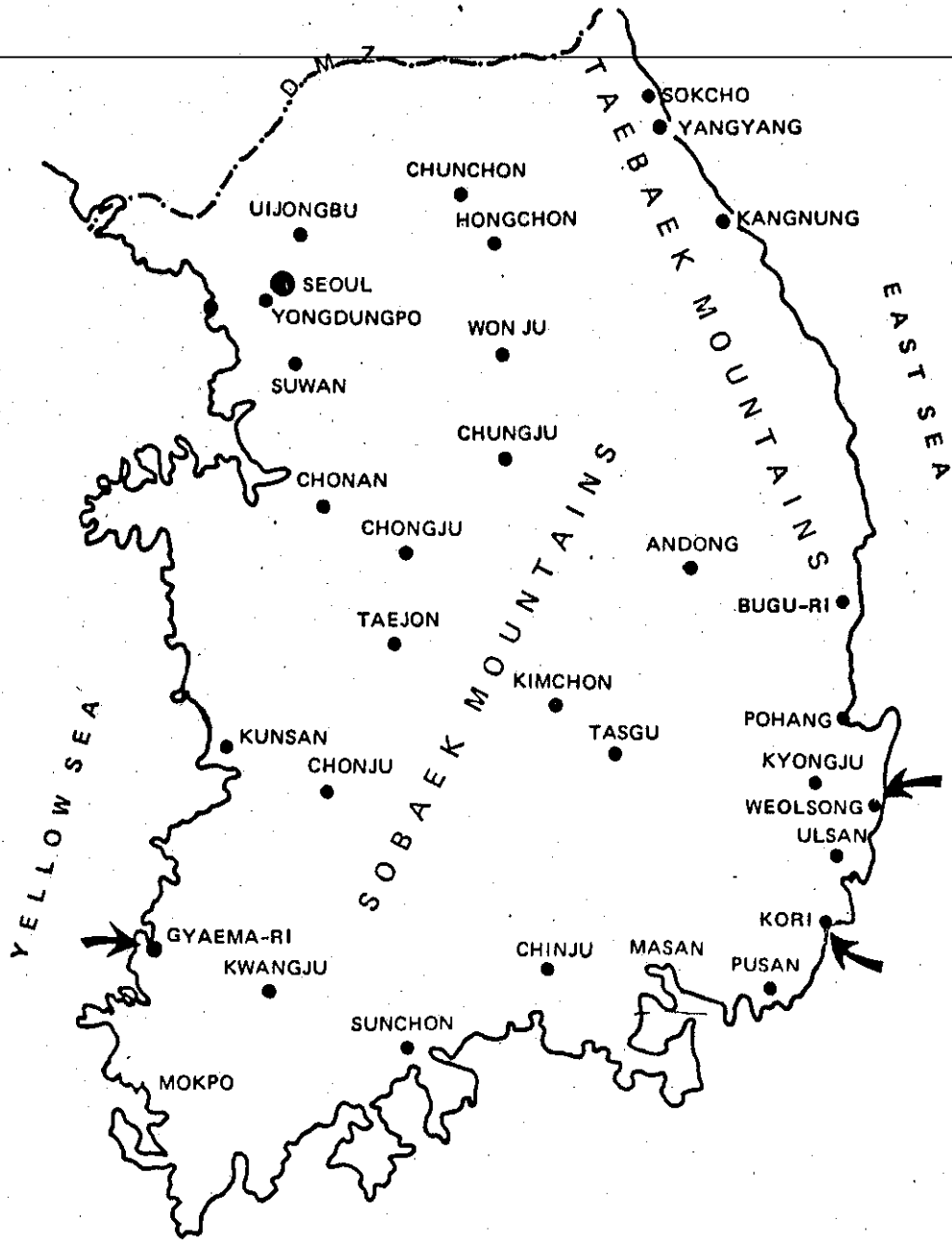
Siting studies performed to date have reduced the number of potential nuclear power plant sites to two: Gyaema-Ri and Bugu-Ri. The locations of these sites are shown in Figure A.1-1. The Gyaema-Ri site appears to be the most suitable of those studied.


The Gyaema-Ri site is on the southwestern coast of the Republic of Korea. Gyaema is approximately 60 kilometers northwest of Gwanju City. Latitude and longitude of the site are 35° 25'N and 129° 25'E, respectively.

##### A.1.3 ACCESSIBILITY

The nearest airport from the site is the Gwangju Airport; at Gwangju, 60 km southeast of the site.

The sea area adjacent to the Gyaema site is open ocean. The site will have docking facilities that can accommodate barges to 3000 tons capacity. It is anticipated that major equipment will be delivered by barge.



	<b>KOREA ELECTRIC COMPANY</b> <b>KOREA NUCLEAR</b> <b>UNITS 7 &amp; 8</b>
	<b>REPUBLIC OF KOREA MAP AND GYAEMA-RI</b> <b>FIGURE A.1-1</b>

The Gyaema site is on District Road, which is approximately 9 km west of National Route 22, the only national road passing through Yeong Kwang-Eub. District Road provides the only land access to the Gyaema plant.

The Honam railway line, Seoul to Mokpo via Kwangju, passes Songjong-Ri Railway station, about 55 km southeast, allowing freight service for the area. At its closest approach, this line passes about 55 km southeast of the Gyaema site.

#### A.1.4 SITE GEOLOGY

The Gyaema site is located within the Hanland physiographic division of Korea (Figure A.1-2). Hanland has been further subdivided into three regions which are, from north to south: Gyeonggi, Ogcheon Taebaeksan, and Gyeongsang. The Gyaema site lies within the Ogcheon Taebaeksan subdivision and the physiography is developed upon Precambrian metasediments and granitic rocks which were intruded during the Daebo orogeny. Figure A.1-3 is a general geology map of Korea.

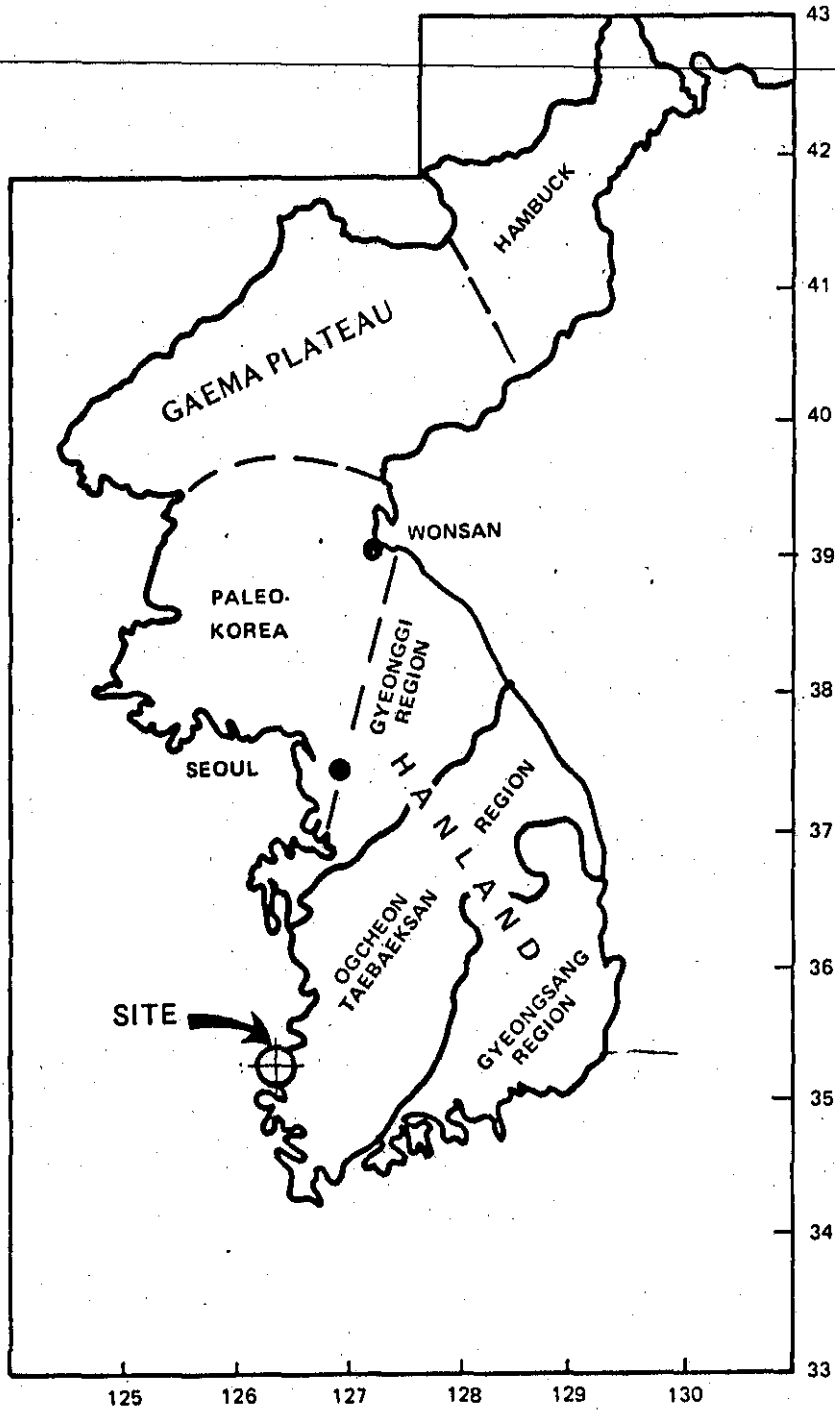
Relief in the Ogcheon Taebaekson region increases westward as the region changes from submergence to emergence. As a result of this regional trend, the Gyaema site area, which is located on the submergent coast, consists of mountain masses dispersed within tidal lowlands. In the sense of a general overview, the central portion of the proposed site area consists of a southern mountainous area separated by an estuary from a central mountainous area which is in turn separated by a second estuary from a northern area of low hills and tidal flats. The western section of the site area is composed of low hills and tidal lowland and, westward, there are a series of small, near-shore islands in the Yellow Sea.

No notable folds or faults were observed within the eight-kilometer site radius. The site area consists of two basic rock types, Cretaceous volcanics and Precambrian metamorphics and intrusives.

Geologic conditions underlying the site are known from the borings conducted at the site and the examination of the outcrops along the seacoast in the immediate vicinity of the site. The table below gives dynamic engineering parameters of foundation rock materials. The site is underlain by volcanic rocks of intermediate to acidic composition. These rocks are covered by zero to five meters of soil developed in place on the underlying volcanics.

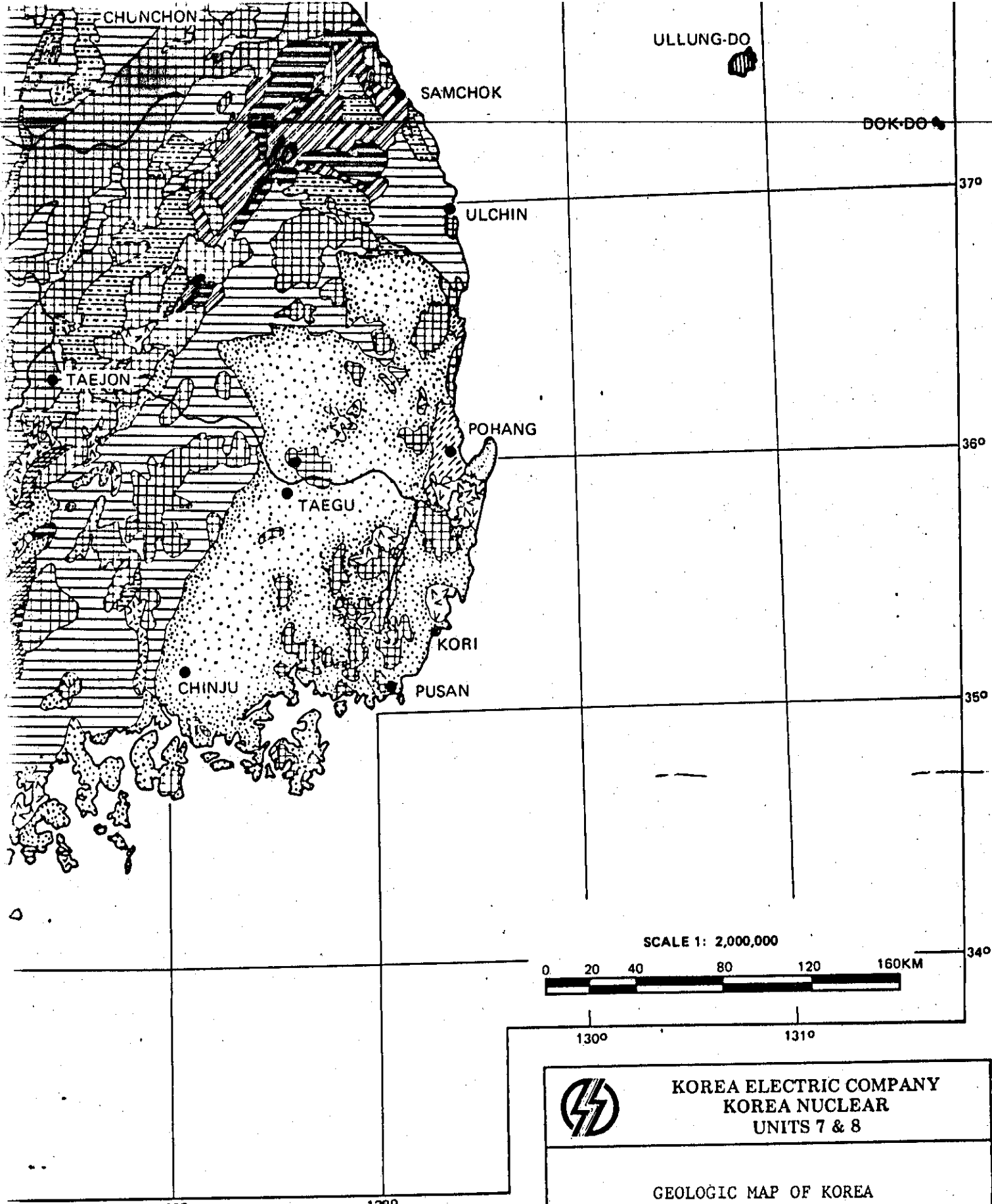
Recommended Dynamic Engineering Parameters of Foundation Rock Materials

<u>Quality</u>	<u>Symbol</u>	<u>Determined Value</u>
Shear Velocity	$V_s$	1,900 m/sec $\pm 10\%$
Compressional Velocity	$V_p$	3,800 m/sec $\pm 10\%$
Poisson's Ratio	$\nu$	0.33
Mass Density	$\rho$	270 kg-sec <sup>2</sup> /m <sup>4</sup>
Shear Modulus	G	$9.7 \times 10^4$ kg/cm <sup>2</sup> $\pm 20\%$
Young's Modulus	E	$2.69 \times 10^5$ kg/cm <sup>2</sup> $\pm 20\%$




	<p>KOREA ELECTRIC COMPANY KOREA NUCLEAR UNITS 7 &amp; 8</p>
<p>MAJOR PHYSTOGRAPHIC DIVISIONS OF KOREA</p>	
<p>FIGURE A.1-2</p>	





SCALE 1: 2,000,000



	<p><b>KOREA ELECTRIC COMPANY</b>  <b>KOREA NUCLEAR</b>  <b>UNITS 7 &amp; 8</b></p>
	<p>GEOLOGIC MAP OF KOREA          FIGURE A.1-3</p>

128°

129°

130°

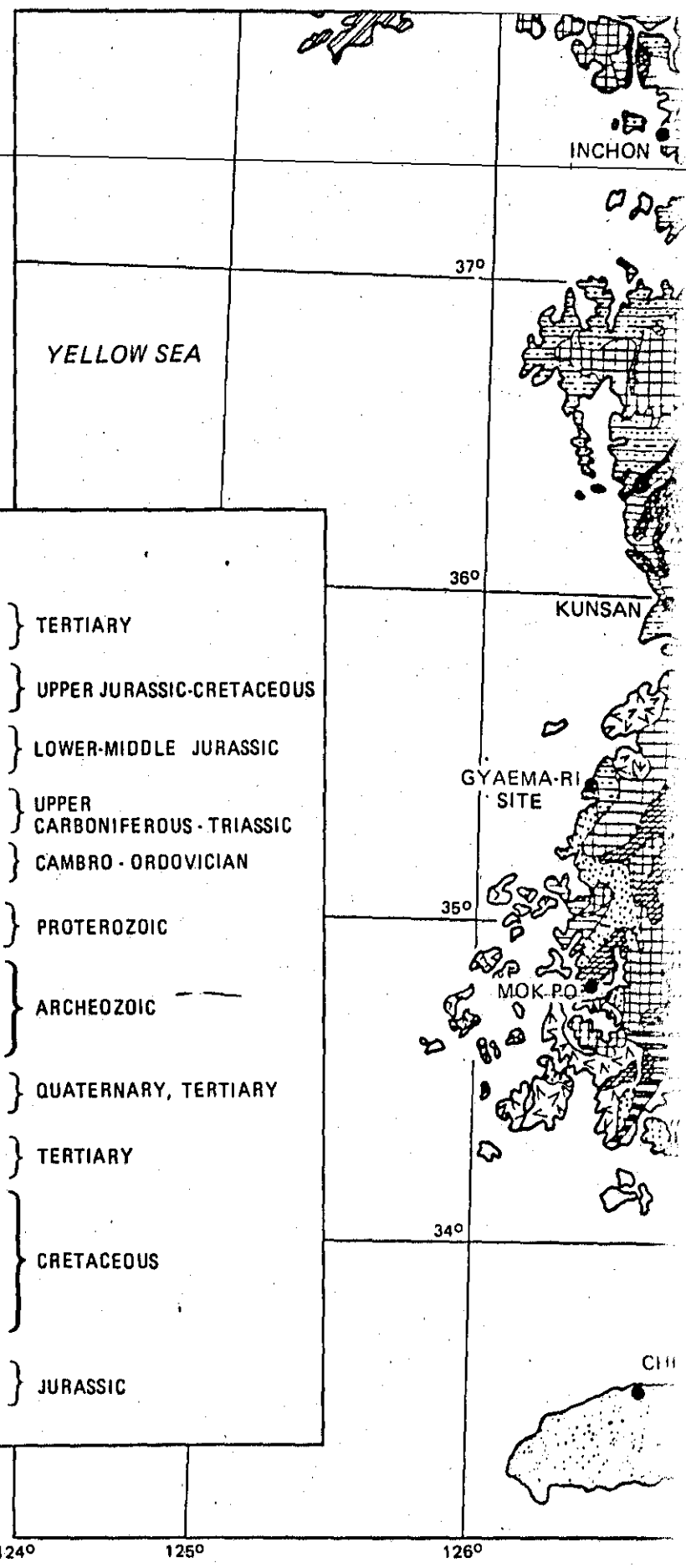
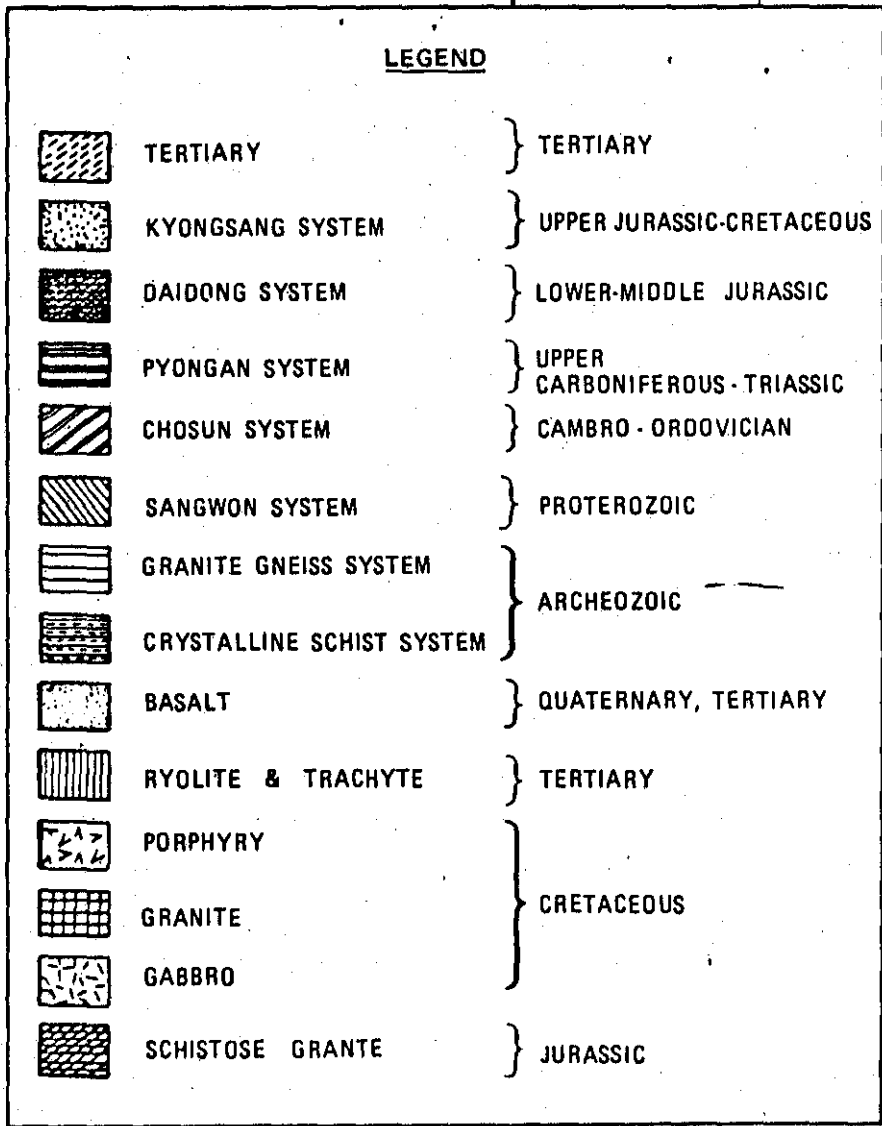
131°

34°

35°

36°

37°



124°

125°

126°

## A.1.6 HYDROLOGY

The site is at Gyaema-Ri, on the southwestern coast of Korea. The site is surrounded by sea on two sides. The eastern sections are bordered by land. There are no streams or rivers that could cause flooding of the site.

High and low seawater levels are as follows:

Highest high-water level	+3.246 meters
High water level	
Spring tide	+2.645 meters
Mean tide	+1.872 meters
Neap tide	+1.099 meters
Mean water level	-0.109 meters
Low water level	
Neap tide	-1.317 meters
Mean tide	-2.09 meters
Spring tide	-2.863 meters
Lowest low-water level	-3.464 meters

Monthly mean values of sea surface temperature and salinity at Gyaema site are:

Month	Sea Temperature (°C)	Salinity (0/00)
	Mean	Mean
1	7	32.3
2	4	32.3
3	4	32.3
4	7	32.0
5	12	32.0
6	17	32.0
7	20	31.7
8	25	31.5
9	25	31.5
10	20	32.0
11	15	32.3
12	11	32.3
Mean	14	32.0

Maximum annual precipitation and maximum 24-hour rainfall at three locations on the shore near the site are:

<u>Location</u>	<u>Maximum Annual Precipitation</u>	<u>Maximum 1 Hour Rainfall</u>	<u>Average Annual Precipitation</u>
Kwangju	178 cm	69 mm	122 cm
Chonju	164 cm	110 mm	124 cm
Yeongkwang	152 cm	51 mm	117 cm

### A.1.7 OCEANOGRAPHY

The site faces outward to the West Sea. Although the sea mud in the Korean waters extends as the southern part of the West Sea, the sea bed on the far side formed the mud with its depth ranging from 5 to 80 meters.

Currents of the West Sea have a reversed character; the major current is the reversed current.

There is no history of damaging tsunamis on the west coast of Korea. The maximum calculated tsunami wave height is negligible.

## A.2 POWER PLANT DESCRIPTION

### A.2.1 ESSENTIAL PLANT FEATURES

Each unit of the nuclear power plant will consist of a light-water cooled and moderated reactor and a turbine-generator, together with necessary supporting auxiliary equipment. Reactor buildings, turbine buildings, and additional building space to house the above equipment as well as the two unit control rooms, offices, laboratories, and other supporting facilities are included. The plant will include a switchyard, warehouse, waste storage areas, and cooling water intake and discharge structures.

The plant will be designed in accordance with applicable requirements and standards of the Republic and Korea Atomic Energy Committee and the U.S. Nuclear Regulatory Commission.

The nuclear steam supply system, consisting of the reactor and associated steam generating equipment, will be the pressurized water type. The PWR is an indirect steam generating cycle wherein the radioactive reactor cooling system is essentially completely separated from the turbine-generator plant. Nonradioactive steam for the turbine-generator is generated by the reactor coolant in shell and tube heat exchangers. Westinghouse will supply the NSSS equipment.

In order to limit the effects of accidentally releasing substantial portions of fission products from a reactor, a reliable containment is provided to completely envelope the reactor system. This containment is designed to withstand the temperature and pressure effects and missiles that may result from a sudden release of mass and energy from the reactor coolant system due to a rupture of the main reactor coolant piping (Design Basis Accident).

The nuclear steam supply system is supported by the following auxiliary systems:

- Chemical and volume control system
- Reactor shutdown system
- Spent fuel storage pool cooling and purification system
- Fuel handling and transfer system
- Sampling system
- Component cooling water system
- Service water system
- Radioactive waste collecting and disposal system
- Heating, venting, and air conditioning system

Engineered safety features systems are provided in addition to safety features already incorporated into the design of the normally operating components of the nuclear steam supply system. These systems reduce the effects of accidents that are equal in magnitude to, or of lesser magnitude than, the Design Basis Accident. The engineered safety features system will perform the following functions:

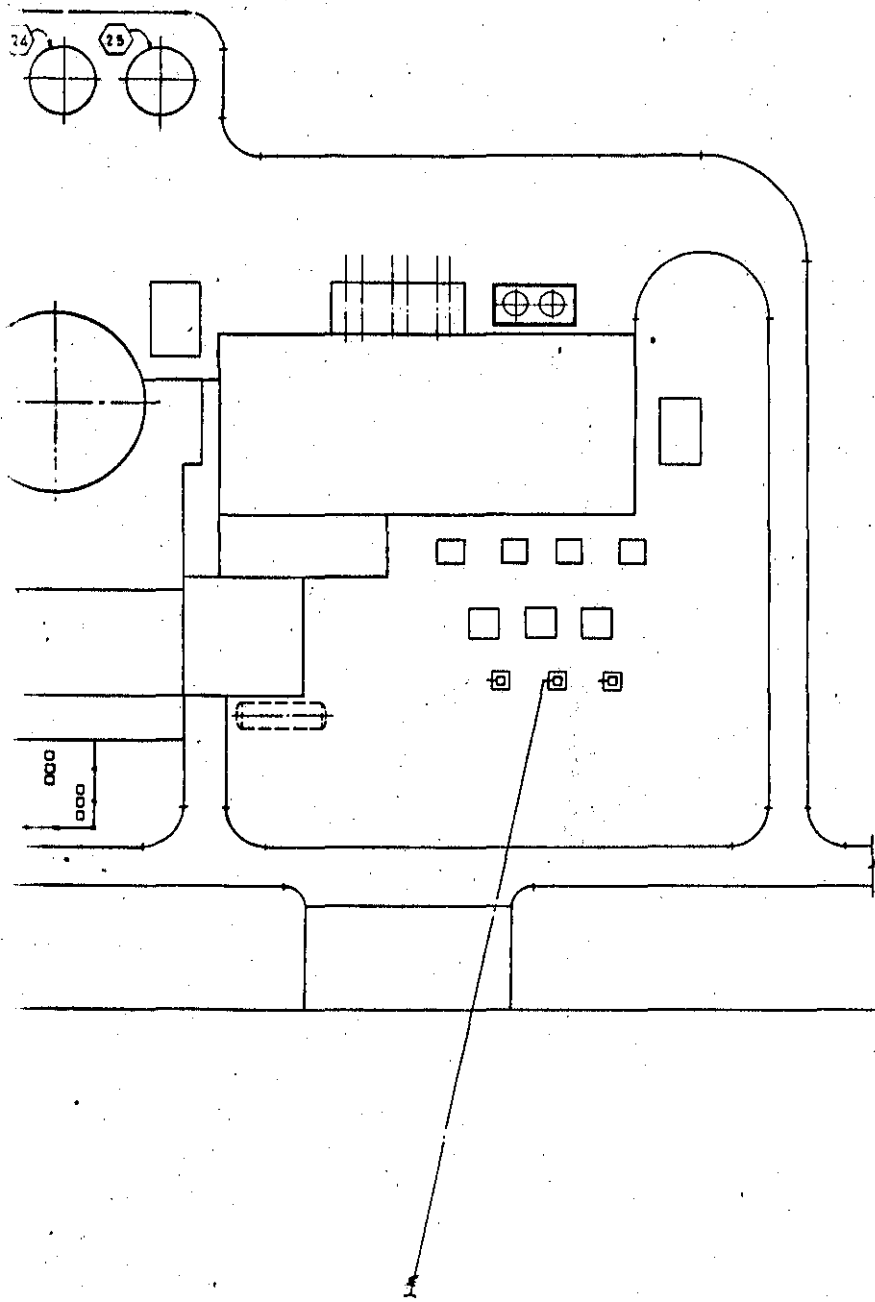
- Render the reactor subcritical
- Isolate the reactor containment
- Remove heat from the reactor containment
- Remove heat from the reactor core

A standby power supply is provided to insure a reliable backup power source for operating these and other essential plant systems.

Each turbine will be a tandem compound 1800-rpm reheat unit, supplied by Westinghouse operating with saturated steam from the nuclear steam supply system and coupled to

**L E G E N D**

- ① REACTOR CONTAINMENT BUILDING
- ② TURBINE BUILDING
- ③ FUEL BUILDING
- ④ COMPONENT COOLING WATER BUILDING
- ⑤ AUXILIARY BUILDING
- ⑥ CONTROL BUILDING
- ⑦ DIESEL GENERATOR BUILDING
- ⑧ ACCESS CONTROL BUILDING
- ⑨ SWITCHGEAR BUILDING
- ⑩ MAIN STEAM SUPPORT STRUCTURE
- ⑪ CONDENSER TUBE PULL PIT
- ⑫ STEAM GENERATOR BLOW-DOWN HEAT EXCHANGER UNIT AND RE-BOILER BUILDING
- ⑬ RADWASTE BUILDING
- ⑭ LUBE OIL STORAGE TANKS
- ⑮ CHEMICAL STORAGE TANK AREA
- ⑯ UNIT AUXILIARY TRANSFORMERS (2)
- ⑰ STEP-UP TRANSFORMERS (3)
- ⑱ START-UP TRANSFORMERS (2)
- ⑲ REACTOR MAKE-UP WATER STORAGE TANK
- ⑳ REFUELING WATER STORAGE TANK
- ㉑ DIESEL FUEL OIL STORAGE TANK
- ㉒ RAW WATER TREATMENT AREA
- ㉓ CLARIFIER SOFTENER
- ㉔ AUXILIARY FEEDWATER STORAGE TANK
- ㉕ CONDENSATE WATER STORAGE TANK
- ㉖ DEMINERALIZED WATER STORAGE TANKS (2)
- ㉗ RAW WATER AND FIRE PROTECTION WATER STORAGE TANKS
- ㉘ OILY WATER SEPARATOR UNIT
- ㉙ H<sub>2</sub> AND N<sub>2</sub> STORAGE AREA
- ㉚ HOT MACHINE SHOP
- ㉛ AUXILIARY BOILER
- ㉜ SPARE STEP-UP TRANSFORMER
- ㉝ SPARE START-UP TRANSFORMER
- ㉞ 345 KV DEAD-END TRANSMISSION TOWERS (3)
- ㉟ 345 KV SF<sub>6</sub> GAS-INSULATED DISC SWITCHES
- ㊱ FIRE PROTECTION PUMPHOUSE
- ㊲ AUXILIARY BOILER FUEL OIL STORAGE TANK W/DKE-2 UNITS
- ㊳ CIRCULATING WATER PUMP BUILDING
- ㊴ NUCLEAR SERVICE COOLING WATER PUMP BUILDING

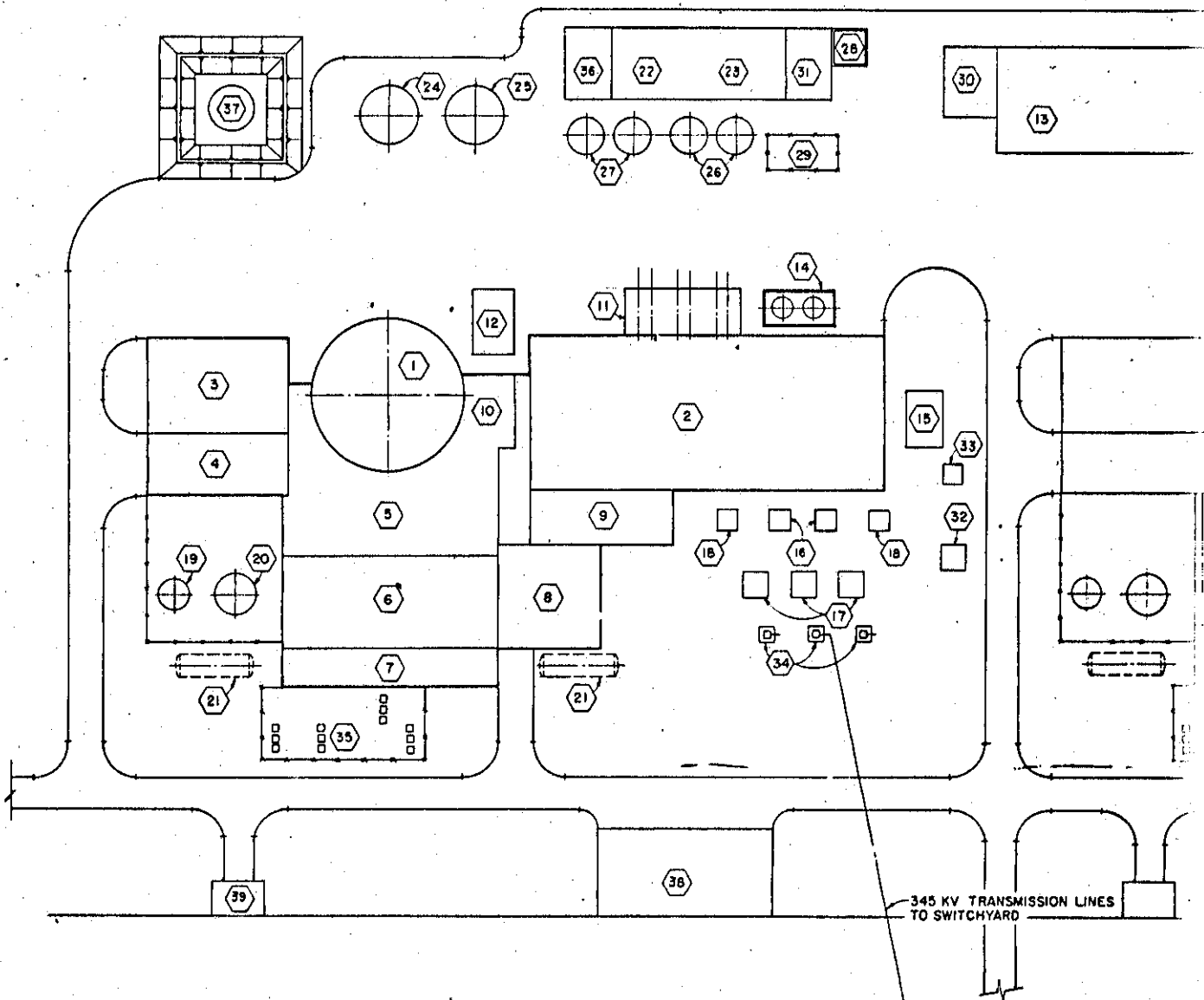


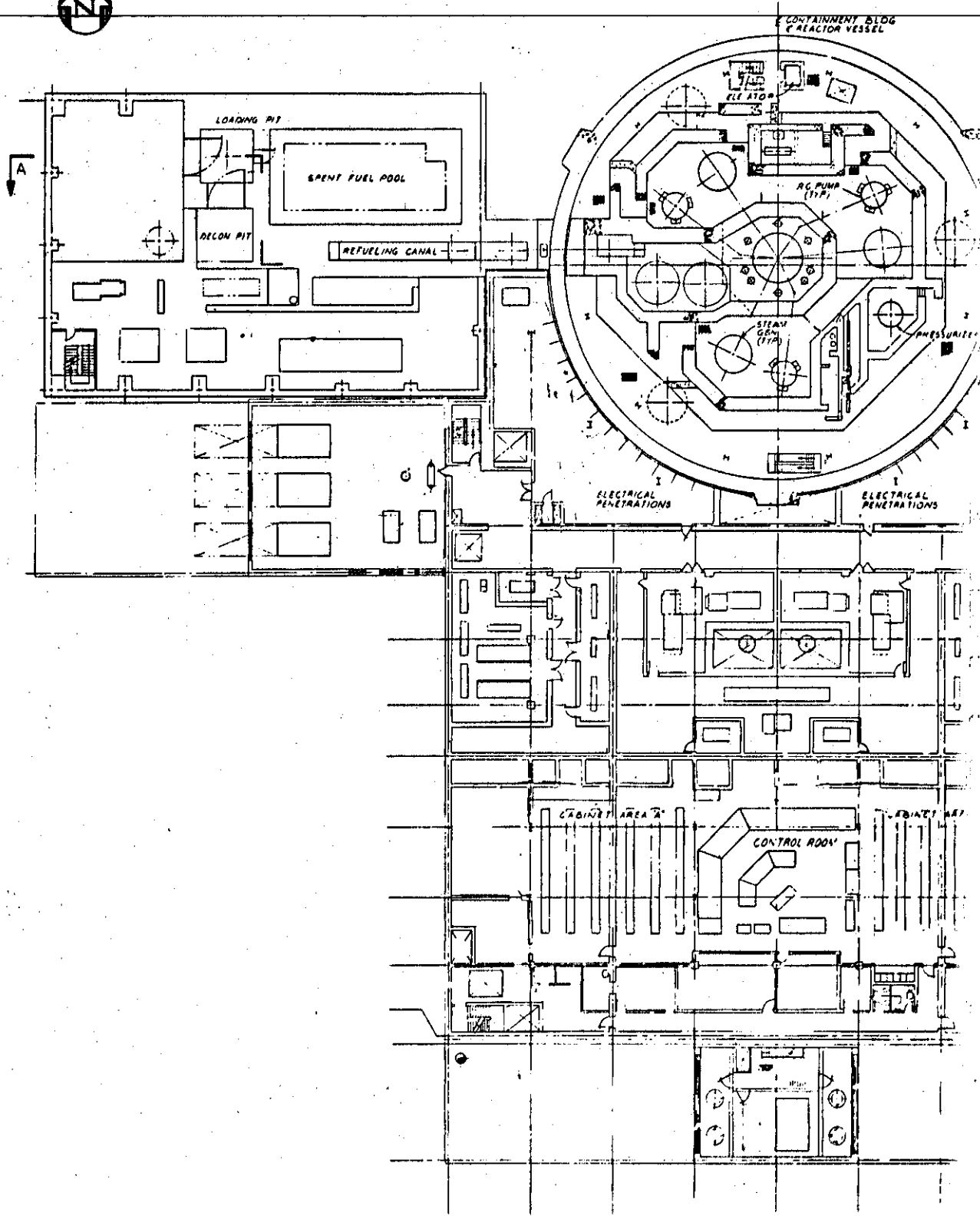
**KOREA ELECTRIC COMPANY  
KOREA NUCLEAR  
UNITS 7 & 8**

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**KEY PLAN  
LIGHT WATER NUCLEAR  
REACTOR POWER PLANT**

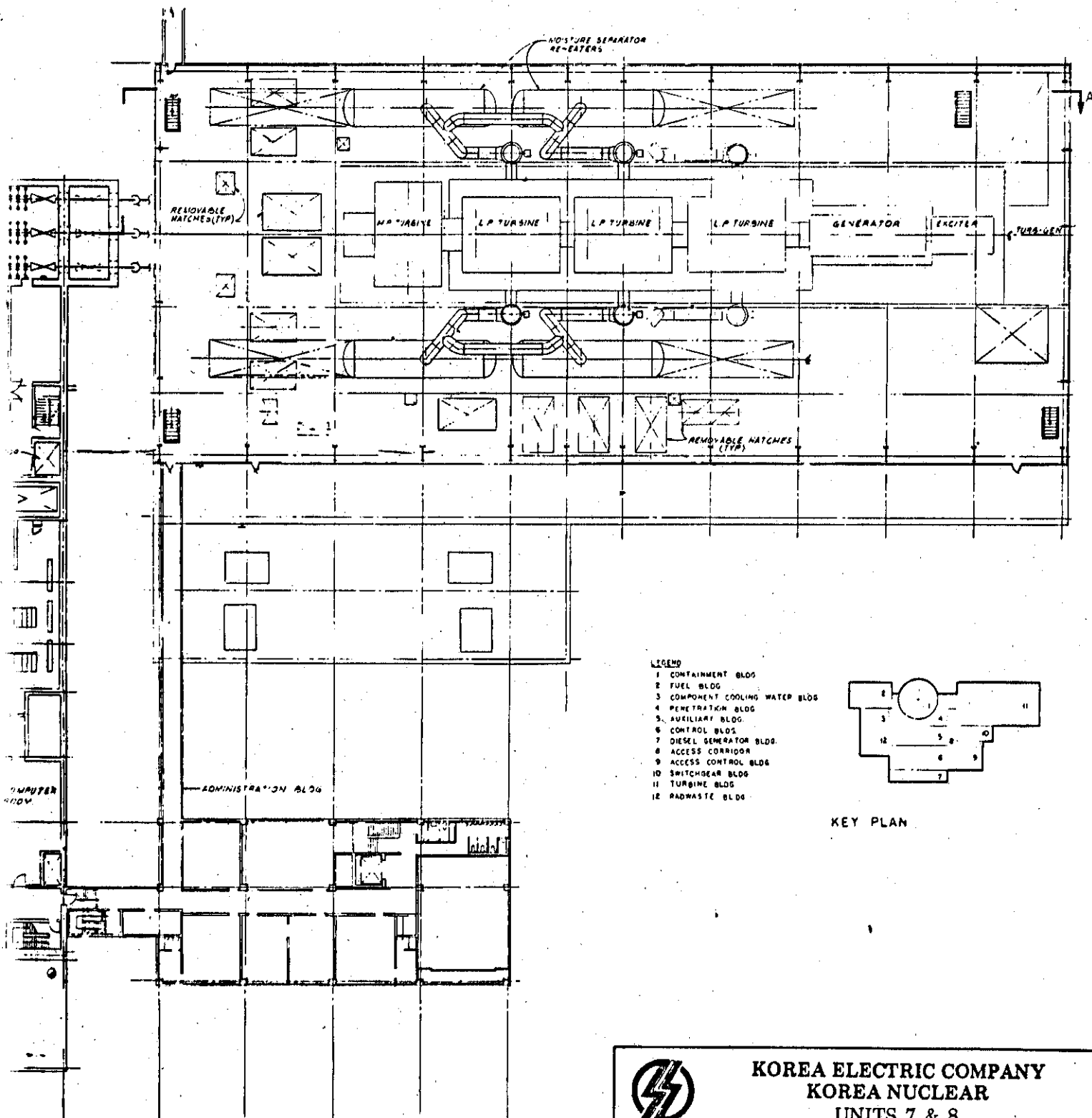
**FIGURE A.2-1**



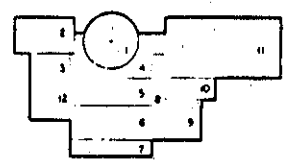


PLAN






- LEGEND
- 1 CONTAINMENT BLDG
  - 2 FUEL BLDG
  - 3 COMPONENT COOLING WATER BLDG
  - 4 PENETRATION BLDG
  - 5 AUXILIARY BLDG
  - 6 CONTROL BLDG
  - 7 DIESEL GENERATOR BLDG
  - 8 ACCESS CORRIDOR
  - 9 ACCESS CONTROL BLDG
  - 10 SWITCHGEAR BLDG
  - 11 TURBINE BLDG
  - 12 RADWASTE BLDG



KEY PLAN



**KOREA ELECTRIC COMPANY**

**KOREA NUCLEAR**

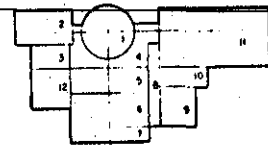
**UNITS 7 & 8**

**PWR POWER PLANT**

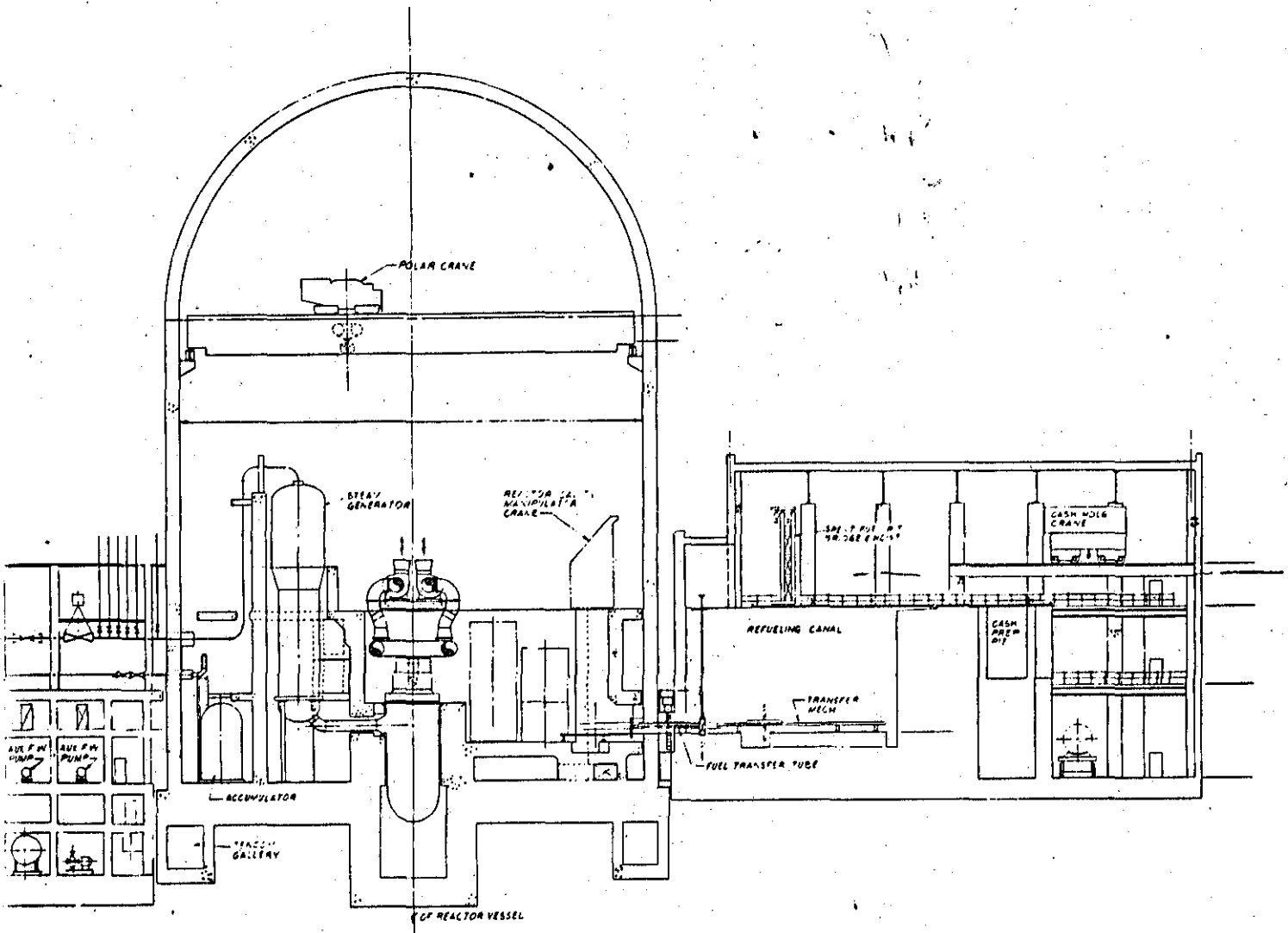
**PLAN**


**FIGURE A.2-2**

- LEGEND
- 1 CONTAINMENT BLDG.
  - 2 FUEL BLDG.
  - 3 CONDENSER COOLING WATER BLDG.
  - 4 PENETRATION BLDG.
  - 5 AUXILIARY BLDG.
  - 6 CONTROL BLDG.
  - 7 DIESEL GENERATOR BLDG.
  - 8 ACCESS CORRIDOR
  - 9 ACCESS CONTROL BLDG.
  - 10 SWITCHGEAR BLDG.
  - 11 TURBINE BLDG.
  - 12 RADWASTE BLDG.



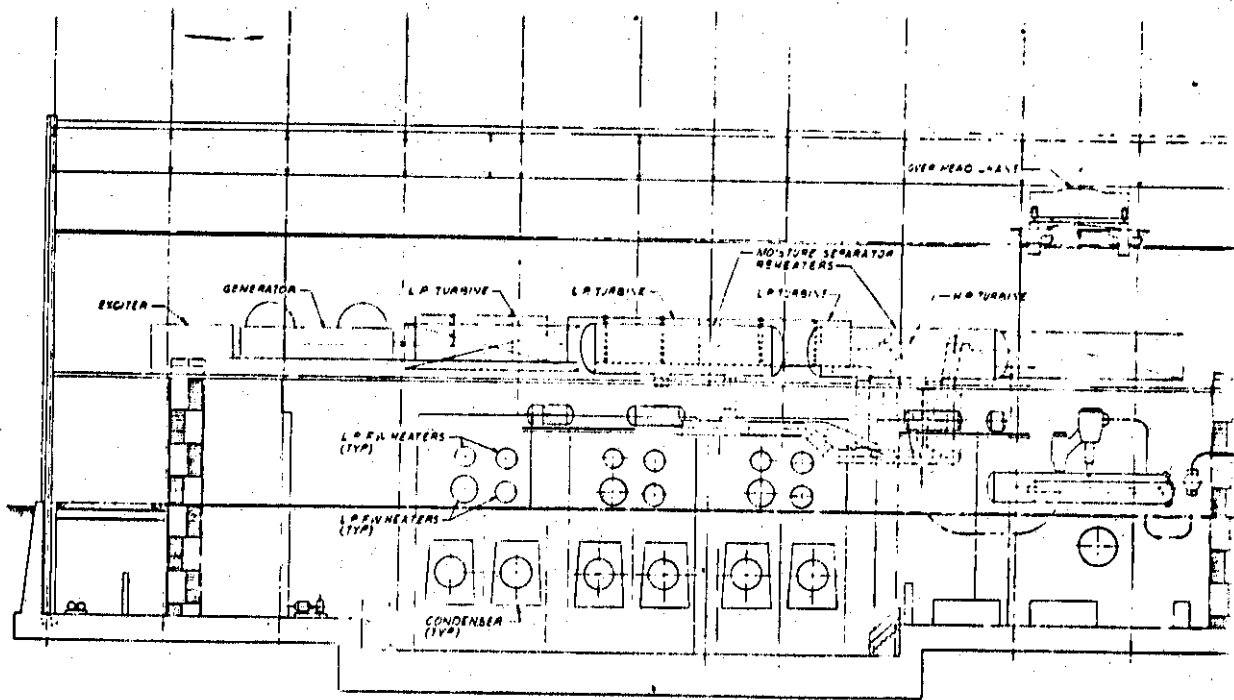
KEY PLAN





**KOREA ELECTRIC COMPANY**  
**KOREA NUCLEAR**  
**UNITS 7 & 8**

**PWR POWER PLANT**  
**SECTION**  
**FIGURE A.2-3**



SECTION 'A-A'

The nuclear steam supply system for a nuclear power plant includes the reactor, reactor cooling system, and reactor auxiliary systems. A brief description for the steam supply system of pressurized water reactors is included below.

### Reactor

The reactor, using purified common water for the coolant and moderator, consists of a carbon steel reactor vessel with a stainless steel liner, internals, core control rods and drive mechanisms, and reactor coolant recirculation system. Control rods are electrically driven and are located on the top of the reactor vessel. Each fuel assembly consists of rods filled with slightly enriched  $UO_2$  fuel pellets, clad with zircaloy and supported by stainless steel internals and guides. The reactor core is designed for a thermal output of 2775 MWt. When the reactor coolant pump heat input of 10 MWt is added to the core output, the resulting warranted NSSS output is 2785 MWt.

### Reactor Coolant System

The reactor coolant system (RCS) uses pressurized ordinary light water to transport heat from the reactor core to the steam generators via closed loops. This coolant performs two additional functions: it moderates fission neutrons to produce a thermal neutron spectrum in the reactor core, and serves as a solvent for boric acid. The regulation of boric acid concentration provides reactivity control (chemical shim control) to compensate for the effects of xenon transients, cold shutdowns and startups, and fuel burnup.

The 997 MWe PWR has three reactor-coolant recirculation loops connected to the reactor vessel in parallel. Each heat transfer loop contains a vertical shell-and-tube steam generator. In addition, a pressurizer is connected to one loop to maintain the RCS pressure during steady-state operation. In the PWR design, the reactor coolant water is pressurized to prevent boiling and the heat transfer mechanism is one-phase flow (sensible heat flow only). A simplified diagram of the PWR plant flow is shown in Figure A.2-4.

### Reactor Auxiliary Systems

The auxiliary systems may be divided into three general categories:

- Systems necessary for normal plant operation including startup
- Systems that back up normal functions or are designed to accommodate emergency or abnormal conditions. These systems are commonly called Engineered Safety Features (ESF) and are described in Section A.2.8.

Major systems that are operated during normal plant operation are described in the following paragraphs.

A. Chemical and Volume Control System

The chemical and volume control system operates continuously during normal operation, as well as during startup, shutdown, and refueling. Water is removed from the reactor and is cooled, filtered, demineralized, then returned to the primary loop.

The system performs the following major functions (1) maintaining the proper neutron absorber inventory in the reactor coolant by adjusting the concentration of the soluble neutron absorber, and (2) maintaining the recirculation loop water inventory by accepting excess water or making up the deficit as the water volume in the loop expands or contracts due to heating or cooling and (3) reducing the concentration of corrosion and fission products in the reactor coolant.

B. Reactor Shutdown System

Prior to refueling or inspection, the reactor shutdown system removes decay heat generated in the core after insertion of control rods along with sensible heat in the system. During refueling or inspection, the system also removes decay heat which is being generated by the reactor core. The heat is removed through heat-exchangers cooled by the component cooling water system. For reactor cooldown, the turbine bypass is actuated to divert a portion of the steam flow directly to the condenser.

C. Spent-Fuel Storage Pool Cooling and Purification System

The spent-fuel storage pool cooling system dissipates decay heat from spent fuel elements in the pool. The cooling system recirculates the pool water, passes it through an auxiliary heat exchanger cooled by the auxiliary coolant system, filters or demineralizes a portion of water to remove impurities, and finally returns the cooled water to the pool as needed. The storage pool is likely to have the capacity to store two complete cores plus the load from one refueling batch. The shutdown system is interconnected with the spent-fuel cooling system and provides added cooling capacity during special conditions, when an entire core may be placed in the pool.

D. Fuel Handling and Transfer System

The fuel handling and transfer system removes fuel elements from the core under a water shield and transfers the elements by local control to the storage pool. New fuel is stored in dry racks. Storage space is provided for one refueling batch plus spares. For refueling, the new fuel elements are transferred to the spent-fuel storage pool whence they are in turn moved to the reactor for insertion in the core.

E. Sampling System

The sampling system monitors operation of NSSS equipment and provides data to make operating decisions. Samples are taken at pertinent points throughout the plant.

#### F. Component Cooling Water System

The component cooling water system is designed to provide the total cooling water flows required by both the essential and nonessential services of the plant nuclear services equipment during all phases of plant operation, including startup through cold shutdown and refueling, as well as during emergency operation.

The function of this system is to remove heat from potentially radioactive systems through their respective heat exchanger and transfer it to the ultimate heat sink. This closed-loop system, using inhibited demineralized water, provides an intermediate barrier between the environment and components containing radioactive fluids, thus reducing the potential for leakage of radioactivity to the environment.

#### G. Service Water System

The service water system provides cooling functions that range from non-safety-related, purely operationally oriented functions to purely safety-oriented functions. As a result, the service water system has both plant operational and safety functions.

#### H. Radioactive Waste Collection and Disposal System

The radioactive waste collection and disposal system collects and processes all radioactive and potentially radioactive plant wastes before discharge or removal from the plant site. Liquid wastes are sampled and analyzed to determine the level of radioactivity prior to release. These liquid wastes are then discharged from the plant under controlled conditions which provide for immediate high dilution. Solid wastes are packed in drums and stored in a waste storage area prior to removal from the site. Radioactive gases are held up to permit decay of short-lived isotopes before release. Release is monitored and is under complete control of the plant operators at all times.

### A.2.4 REACTOR CONTAINMENT

Design features of reactor plants, such as interlocks, instrumentation and control, reactor protection system, alarm system, emergency cooling system, relief and shutdown system, and standby power systems, are carefully chosen to provide a safe, stable, and reliable plant. The potentially undesirable consequences of accidents leading to the release of substantial portions of the fission products from a nuclear reactor, however, require provisions for limiting the effects of such accidents. A reliable containment completely enveloping the reactor system is provided for this purpose.

For purposes of safety analysis, the containment is designed to withstand the temperature and pressure effects due to a severe accident referred to as the Design Basis Accident (DBA). This accident is defined as the sudden release of mass and energy from the reactor coolant system due to a massive rupture of the main reactor coolant piping. The containment is designed to resist the internal pressure surges, jets, and missiles created by the accident.

Furthermore, the containment is designed to maintain its integrity consistent with environmental factors including population density; meteorological, typhoon, and seismological regimes; and use of the surrounding land.

For a PWR, the reactor containment consists of a steel liner within a prestressed concrete structure. The reactor (primary) coolant recirculation loop, which is under high pressure at high temperature and is contaminated with nuclear fission and activation products, is confined within the structure which can withstand the effects of the Design Basis Accident. The structure is designed to confine fission products released by the DBA and to provide adequate biological shielding outside the containment for post-accident conditions.

### A.2.5 TURBINE-GENERATOR PLANT

Saturated steam supplied by light-water reactors currently available requires that turbine design accommodate large-volume flows at both inlet and exhaust. Large-diameter low-speed turbines lend themselves readily to large volumes of steam, since the low pressure and temperature at the throttle permit the use of large-diameter single-shell casings with acceptable bolting stresses. Thus, today, all of the large 60-Hz turbine-generator units coupled to light-water reactors are designed for 1800 rpm. The low-speed design allows a large last-stage bucket annulus area with modest tip speed, thus reducing erosion from impact with the wet steam. To further minimize the undesirable effects of wet steam, the moisture content of steam through the turbine is reduced by special design provisions, such as internal moisture separators, external moisture separator-reheaters, moisture removal buckets, and casing traps for BWR and PWR turbine units.

To provide operating flexibility, and to protect the reactor against overpressure under abnormal operating conditions, a pilot-actuated pressure relief system dumps steam to the condenser and atmosphere.

The turbine is a tandem compound six-flow 1800-rpm reheat unit.

The generator is an 1800-rpm, three-phase, 60-Hz hydrogen or water inner-cooled unit. A rotating brushless, or static excitation system is used with the main generator.

The turbine-generator unit is rated for operation at the NSSS warranted output of 2785 MWt with a corresponding electrical output of 997 MWe at the generator terminals.

The turbine plant has the normal complement of service systems necessary to operate safely and efficiently. These include the lubricating oil, compressed air, fire protection, circulating water, turbine building cooling water, and makeup water systems.

### A.2.6 ELECTRICAL FEATURES

The electrical features of a nuclear power station are similar to those of any conventional thermal power station, except that an extremely reliable power system containing redundancy is required for auxiliary equipment associated with the nuclear reactor. This is in addition to

the usual highly reliable power source for plant auxiliary equipment in a conventional power station. The electrical power output of this plant will be fed into KECO's system over two double-circuit transmission lines: one to Haeundae substation, and the other to Sinpohang substation. Power for plant auxiliary equipment can be obtained from either substation.

### Major Electrical System and Equipment

The major electrical system for power generation is arranged on a unit-system basis, consistent with the mechanical system arrangement. Unit auxiliaries for both the nuclear reactor and the power block are supplied normally by the unit which they serve. Major electrical plant items for each unit are described below:

A. Generator

900 to 1,000 MVA gross, 22 kV, 60 Hz, 90 percent power factor, 1800 rpm, complete with excitation equipment, isolated phase bus duct, neutral grounding equipment, surge protection, meters, protective relays, voltage regulator, control equipment, and cooling equipment.

B. Main Transformer Bank

1050 MVA, 22 kV delta, 345 kV Y, three-phase, forced oil, forced-air cooled. The high-voltage side neutrals are alternatively grounded through high-speed neutral grounding switches.

C. Switchyard Equipment

Power circuit breakers are rated at 345 kV (nominal). Other equipment will be provided as required by system continuous current capacity and short-circuit duty.

D. Unit Auxiliary Transformer

The unit auxiliary transformer is energized from the 22-kV generator main leads. The capacity is based on power required for continuous full-load operation of plant auxiliaries for one unit under normal operating conditions. The number and ratings of windings and intermediate voltage levels will be determined by load and short-circuit duty requirements.

E. Startup Transformers

Each of the two startup transformers is energized from the 345-kV system in the switchyard, connected to Haeundae and Sinpohang substations. Each source is a preferred power supply. The capacity of each transformer is based on the power required to start one unit and simultaneously shut down the second unit, while supplying power to the Engineered Safety Features necessary for reactor shutdown of that unit. The capacity of each transformer is adequate to supply the power required to operate the auxiliaries of one unit at full rated load and simultaneously shut down the other unit.



## F. Standby Power Generating Units

Diesel engine generators will provide power to shut down the reactor during the loss of all offsite power. Redundant ESF buses are provided with each reactor system. Each bus is fed from a separate diesel-drive standby generator. There is no interconnection between the ESF systems for the two reactors in the plant.

### Switchyard

For a reliable power supply, and because of the large unit size of the generator, a 345-kV switchyard will be built to serve this station.

As shown in Figure A.2-5, the switchyard is a double-bus arrangement, using a breaker and one-half scheme, accommodating station generators, outgoing transmission lines, and station startup transformers. The 345-kV circuits serve three purposes: (1) transmit power to the system, (2) receive power for plant startup or shutdown, and (3) furnish redundant sources of power for the ESF power system associated with each reactor.

### Electrical Auxiliaries – Power System and Equipment

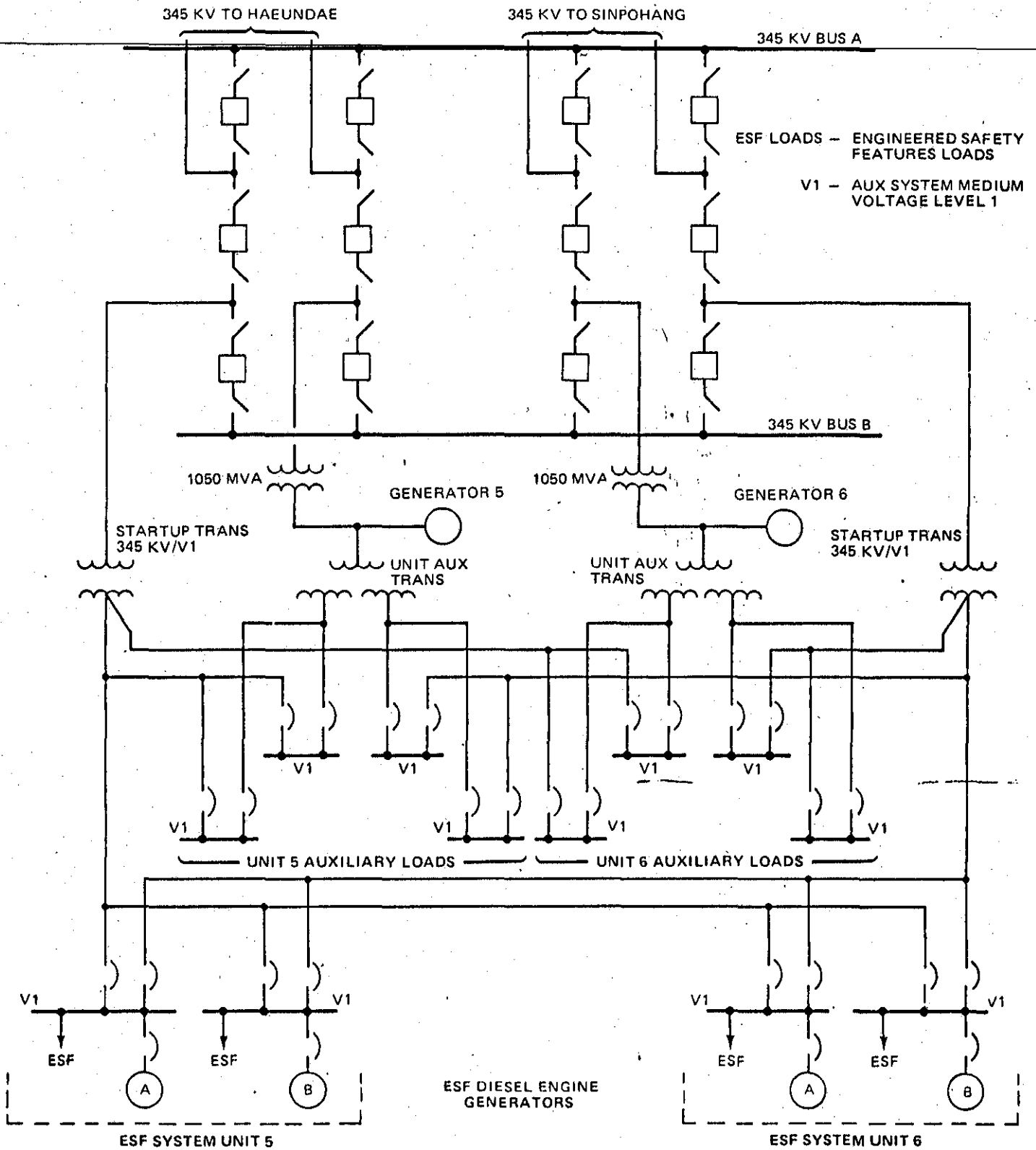
The electrical power supply for the nuclear reactor and auxiliary equipment of each unit requires a high degree of reliability to assure reactor safety during all phases of operation, including shutdown periods. Basic requirements for the auxiliaries include:


- An adequate power source for normal cooling water pumping and other auxiliary loads
- The most reliable power source in accordance with USNRC criteria to supply cooling water during a shutdown
- Means of providing adequate cooling water during a transient period of shutdown
- Safety devices that are highly sensitive, accurate, and of the fail-safe type, which will shut down the reactor in an emergency

Considering the performance and natural condition of KECO's transmission and distribution system, the following power sources will be provided:

#### A. 345-kV System

Two double-circuit transmission lines connect Korea Nuclear Units 7 and 8 with two separate substations in KECO's extra high-voltage system. During startup, the auxiliaries of one generator unit in the plant receive power through both of the startup transformers. After paralleling the generator with the system, the auxiliary electrical system for that unit is manually transferred to the unit



	<b>KOREA ELECTRIC COMPANY</b> <b>KOREA NUCLEAR</b> <b>UNITS 7 &amp; 8</b>
	ONE-LINE DIAGRAM FIGURE A.2-5

auxiliary transformer. The startup transformers remain energized from the 345-kV system and act as redundant preferred power sources for the ESF systems of each of the reactors, and as backup power sources for the unit auxiliary transformer. If necessary, a startup transformer can supply power to the auxiliary system of one of the generator units, in addition to power for the ESF systems.

**B. 22-kV System**

Each generator provides 22-kV output; this supplies power to the unit auxiliary transformer for the turbine-generator and input to the main step-up transformer.

**C. Standby Power Source**

Redundant quick-start diesel-driven generator units will supply emergency power to shut down each unit of the plant if an offsite power supply is not available. Each redundant system can provide power for a safe shutdown of the reactor. There is no interconnection between the standby power systems of Korea Nuclear Units 7 and 8.

Selection of the auxiliary system medium-voltage levels will be based on the size of motors, length of circuits, continuous current, and short-circuit duty requirements. Both economical and technical features need to be carefully considered. Tentatively, 6600-V, three-phase, low-resistance grounded systems are proposed in conjunction with each unit.

In the selection of low-voltage levels, the principles given for the selection of intermediate voltages will be followed. Tentatively, a 277/480-V, three-phase, four-wire solidly grounded system is proposed.

Since there are many power sources available to the auxiliary system of each unit, a positive means of automatic transfer with interlocking will be used to achieve safe and reliable operation of the plant.

Storage batteries and chargers are used for direct current power and control. Batteries will be operated on a floating charge to maintain full capacity under normal operating conditions. The voltage(s) of the direct current system and capacity of the batteries and chargers selected will provide optimum performance for all control and protective equipment under normal and adverse conditions.

## **A.2.7 CONTROL SYSTEMS**

The basic function of a power plant is to supply electrical energy on demand to the power distribution network. This demand represents a load to the plant turbine-generator. To meet this demand (load), the NSSS must respond with the correct flow of preconditioned steam to the turbine.

The control system has two objectives: (1) control reactor temperatures so that steam output matches turbine-generator requirements; (2) operate the NSSS safely, reliably, and economically.

All controls and instruments essential to normal and emergency plant operations will be designed to protect plant personnel and equipment, and will be installed in a central control room. Thus, the nuclear power plant control room contains the operating and information equipment necessary to control and monitor plant systems during normal and emergency plant operation.

The control room contains manual and automatic controls and setpoint adjustments to monitor the reactor, important reactor auxiliaries, the feedwater-steam circuit, the turbine, the generator, and the auxiliary power equipment.

Controls and instrumentation required only for maintenance and testing, or where local operator manual participation is required, will be placed at convenient locations throughout the plant. An auxiliary shutdown panel provides a secondary control point for the operators to establish and maintain safe hot shutdown conditions in the unlikely event of control room abandonment.

Control systems that are typical of a nuclear power plant are described in the following paragraphs.

### Reactor Control and Regulating System

The reactor control system is designed to follow load changes as they occur at the turbine. All reactor power level changes are made by control rod adjustments. The control system automatically adjusts the power level of the reactor to match the power demanded by the turbine. The turbine load determines a reference temperature ( $T_{ref}$ ) that corresponds to the reactor power level required to meet the turbine demand.

The reactor coolant average temperature control program performs the following functions:

- Maintains a programmed reactor coolant temperature setpoint ( $T_{ref}$ ) by regulating the control rods
- Limits rapid load transients in the reactor coolant system by regulating steam flow through the turbine bypass control valves to the condenser on large loss of turbine load
- Maintains zero-power temperature setpoint during hot shutdown, by regulating steam flow through the turbine bypass control valves to the condenser

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### Reactor Neutron Monitoring System

The reactor neutron monitoring system protects the reactor core by monitoring the neutron flux and generating appropriate trips and alarms for various phases of reactor operating and shutdown conditions. It also provides a secondary control function by indicating reactor status during startup and power operation.

The nuclear instrumentation system monitors reactor power from the source range through the intermediate range up to 120% of full power output. Thermal neutron flux detectors in instrument wells in the primary shield adjacent to the reactor vessel provide indication, control, and alarm signals for reactor operation and protection.

### Reactor Protection System

The reactor protection system monitors the plant for abnormal conditions, alerts the operator to take corrective action and prevent the further development of abnormal conditions, and provides automatic reactor trip (shutdown) whenever conditions, as monitored by nuclear instrumentation and process instrumentation, reach the operational limits.

The reactor protection system consists of two discrete circuits: the analog circuit consisting of multiple redundant channels that monitor various plant parameters, such as the reactor coolant temperature, neutron flux, pressurizer pressure and level, and steam generator level; the digital circuit consisting of two redundant logic trains that receive input from the analog protection channels, and that contain the logic needed to initiate reactor trips.

### Radiation Monitoring System

The radiation monitoring system provides information for the protection of people from the physiological effects of nuclear radiation. The use of this system in a nuclear reactor plant assures the safety of both operating personnel and the community, by warning of and/or prevention of a potentially hazardous condition. In addition, the system is designed to monitor any unusual sources of radioactive contamination, and to assist in maintaining radiation levels within the requirements of 10 CFR 20 Appendix B (Code of Federal Regulations, Title 10, Part 20).

### Computer System

Major emphasis in a nuclear plant is placed on plant performance and availability. This requires close monitoring of the nuclear steam supply system (NSSS) and balance of plant (BOP) performance variables, and a way to conveniently present pertinent data to the operator. The online computer system provides a centralized data collection system and performs onsite computation of specific performance parameters to supplement the NSSS and BOP instrumentation systems in the achievement of this goal. The computer system will supervise reactor control and protection systems, the NSSS process systems, and the secondary systems with online data acquisition, alarming, logging, and data reduction.

## Turbine-Generator and Auxiliary Power Control

The main turbine-generator control system will be designed for base load or load-following operations. The main turbine system functional limitation imposed by the NSSS is step-load changes of 10% and ramp load changes of 5% per minute over the range of 15 to 100% of rated (guaranteed) power. The turbine-generator is capable of accepting a load rejection of 50% of maximum guaranteed power without causing a reactor trip and without steam release to the atmosphere.

The turbine control system provides turbine protection during conditions such as turbine overspeed, excessive thrust bearing wear, low bearing oil pressure, low condenser vacuum, or low electrohydraulic control fluid pressure.

### A.2.8 ENGINEERED SAFETY FEATURES

Nuclear power plant design incorporates a number of Engineered Safety Features (ESF) that protect both the public and operating personnel from radiation hazards under all abnormal operating conditions. These Engineered Safety Features are in addition to those safety features included in the design of the reactor, reactor coolant systems, containment systems, control system, and other instrumentation or process systems normally provided. The ESF discussed herein serve no function necessary for normal plant operation. They are included for the sole purpose of reducing the consequences to the public of various postulated accidents, or of limiting the potential radiation dose to generally recognized values.

In the case of a PWR, the potential dose is reduced by immediate, automatic isolation of all containment penetrations for processes that are not required to limit the consequences of the accident, thereby eliminating potential leakage paths. Long-term potential releases following the accident are minimized by rapidly reducing the reactor building pressure to near-atmospheric within 24 hours, thereby reducing the driving potential for fission product escape.

In addition, ESF prevent core meltdown should the worst postulated loss-of-coolant accident (DBA) occur. This is accomplished by large capacity water injection emergency core cooling systems, parts of which are continuously operated for normal purposes and are immediately available for emergency duty. These systems, coupled with the thermal, hydraulic, and blowdown characteristics of the reactor, will reliably prevent metal-water reactions and core melting (or core disfiguration into a geometry which could prevent further cooling).

Providing a habitable environment in the control room following an accident is another ESF function. In this environment, the plant operators take the necessary actions to maintain the plant in a safe shutdown condition after automatic action is complete.

Current safety-related topics of most intense investigation in the U.S. are the emergency core cooling system (ECCS) effectiveness, pipe break analysis, and anticipated transients without reactor tripping. The latest answers to these questions will be included in the (later) scope of supply.

Typical ESF systems related to PWR power plants include:

- High-pressure injection system
- Core flooding system
- Low-pressure injection
- Containment spray system
- Containment cooling system
- Containment isolation system
- Combustible gas control system
- Habitability systems

## A.2.9 STRUCTURAL DESIGN

The design of all structures and facilities will conform to the applicable codes and specifications currently used in the U.S. for the design of nuclear power plants, such as Uniform Building Code (UBC), American Institute of Steel Construction (AISC), American Concrete Institute (ACI), etc.

### Classification of Structures, Systems, and Equipment

Plant structures and process systems are classified according to their function and the degree of integrity required to protect the public, as Category I or Non-Category I.

Category I structures, components, and systems are defined in accordance with USNRC Regulatory Guide 1.29 as those necessary to assure:

- The integrity of the reactor coolant pressure boundary
- The capability to shut down the reactor and maintain it in a safe shutdown condition
- The capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures comparable to the guideline exposures shown in 10 CFR 100:



Category I structures, components, and systems are designed to withstand the Safe Shutdown Earthquake (SSE) and other applicable loads without loss of function. Category I structures are sufficiently isolated or protected from other structures to ensure that their integrity is maintained at all times.

Non-Category I components (and their supporting structures), whose collapse could result in loss of required function through impact or flooding of Category I structures, equipment, or systems, are analytically checked to determine that they will not collapse when subjected to the SSE.

### Seismic Design

Appropriate USNRC regulations and regulatory guides will be used as the basis for seismic analysis. Horizontal and vertical accelerations will be assumed to act simultaneously.

Currently, the two intensities of design earthquakes in the U.S. are designated as:

- Operating Basis Earthquake (OBE)
- Safe Shutdown Earthquake (SSE)

The Operating Basis Earthquake is that earthquake which, considering the regional and local geology and seismology and specific characteristics of local subsurface material, could reasonably be expected to affect the plant site during the operating life of the plant. It is that earthquake which produces the vibratory ground motion for which those features of the nuclear power plant necessary for continued operation without undue risk to the health and safety of the public are designed to remain functional.

The Safe Shutdown Earthquake is that earthquake which is based upon an evaluation of the maximum earthquake potential considering the regional and local geology and seismology and specific characteristics of local subsurface material. It is that earthquake which produces the maximum vibratory ground motion for which Category I structures, systems, and components are designed to remain functional.

### A.3 NUCLEAR FUEL SUPPLY

The fuel management program will be developed in collaboration with the NSSS supplier (Westinghouse) and the fuel supplier. Fuel management and the procurement of fuel material and services will be done judiciously on a sound technical basis to achieve lowest fuel cycle costs.

## A.3.2 FUEL COST

### A. Method

The first core fuel fabrication for nuclear Units 7 and 8 will be purchased from Westinghouse, nuclear steam supply system (NSSS) supplier.

The complete fuel-cycle cost includes costs of the direct fuel-cycle and the indirect charges on the working capital necessary to finance the fuel inventory. Direct fuel-cycle costs include purchase of uranium, conversion to  $UF_6$ , isotopic enrichment, reconversion to  $UO_2$ , fabrication, and shipment of fuel to the plant site.

The present-worth method was adopted to compute fuel-cycle cost.

### B. Fuel-Cycle Cost Data

Based on standard PWR fuel management data and cost projection for standard PWR fuel, the fuel cycle cost data have been computed. Assumed plant capacity factors are tabulated in Table A.3-1.

The design, operation, and representative economic parameters governing the fuel-cycle cost computation for the various types of reactors considered are summarized in Tables A.3-2 to A.3-4.

Fuel-cycle costs evaluations were based on a 25-year plant life for each unit after plant startup referenced to March 31, 1986 (Unit 7). The projected prices for various fuel-cycle components are given in Table A.3-4 with the corresponding escalation rates. The unit energy costs were leveled to March 31, 1986 (Unit 7). ~~The results of these calculations with escalation are summarized in Table A.3-5.~~ These were developed using an annual interest rate of 8.675 per cent and present worth rate of 10 percent.

Table A.3-1  
PLANT CAPACITY FACTORS

Year	Assumed Capacity Factor %
1	60
2	70
3 to 10	80
11 to 20	73
21 to 25	70

CFs.

Table A.3-2  
CORE DESIGN PARAMETERS

Item	Parameter
Core Thermal Power (MWt)	2,775
Power Level, (Net) (MWe)	937
<u>Plant Efficiency (%)</u>	<u>33.8</u>
Station Heat Rate (Btu/kWh)	10,011
Initial Core Loading (metric tonne U)	<b>66.507</b>
Fuel Enrichment When Charged into Reactor (%)	
1st core	2.36
Equilibrium core	3.13
Fuel Enrichment when Discharged from Reactor (%)	
1st core	0.71
Equilibrium core	0.69
Average Fuel Exposure (MWD/metric tonne U)	
1st core	23,629
Equilibrium core	35,887
Plutonium Concentration in Discharged Fuel (g/kg U)	
1st core	5.44
Equilibrium core	6.43
Fuel Management Program (fraction of core replaced during annual refueling outage)	1/3

**Table A.3-3  
FUEL-CYCLE COST PARAMETERS**

Item	Parameter
Lead – Lag Time <sup>(1)</sup> (days)	
U <sub>3</sub> O <sub>8</sub> Procure	90
Ship and convert to UF <sub>6</sub>	60
Enrich	90
Fabricate	120
Ship to site, store <sup>(2)</sup>	150
Spent-fuel cooling	180
Losses <sup>(3)</sup> (%)	
U-conversion	0.5
U fabrication	0.75

**Notes:**

- (1) Payments are made at the beginning of the processing period except that the enrichment payment is made at the end of the period and the fabrication payment is made during midpoint of the period.
- (2) On first core only, additional time of 180 days is allowed for startup phase.
- (3) Losses included in fuel price calculations.

**A.3.3 FUEL SCHEDULE**

The fuel schedule for Unit 7 is given in Table A.3-6, and for Unit 8 in Table A.3-7. Fuel batches 1, 2, and 3 represent initial core loadings in the 3 zones of the reactor core. Fuel batches 4, 5, and 6 are the first three reload batches.

Table A.3-4

PROJECTED FUEL-CYCLE COST DATA<sup>(1)</sup>

Year	U <sub>3</sub> O <sub>8</sub> (\$/lb)	Conversion (\$/kg U)	Enrichment <sup>(2)</sup> (\$/kg SWU)	Fabrication Including Shipping (\$/kg U)	Disposal of Spent Fuel <sup>(3)</sup> (\$/kg U)
1979					
1980					
1981					
1982					
1983					
1984					
1985					
1986					
1996					
1997					
1998					
1999					
Esca- lation (%/yr)	5.0	6.0	10.0	7.0	7.0

Notes:

(1) Unescalated base date, July 1, 1979 prices

(2) Tails concentration: 0.20 w/o U-235

(3) Including shipping cost for permanent disposal

**Table A.3-5  
LEVELIZED FUEL-CYCLE COSTS**

Item	PWR, Escalated	
	Unit 7	Unit 8
Thermal Output (MWt)	2785	2785
Electric Output (MWe) (Gross)	997	997
Levelized Date	Mar. 31, 1986	Mar. 31, 1987
Total Present Worth of Fuel Costs (\$ Million)	<u>868.244</u>	<u>919.145</u>
Total Present Worth of Energy (10 <sup>12</sup> Btu)	597.305	597.305
Unit Levelized Fuel Cost (¢/MMBtu)	145.36	153.88

**Table A.3-6  
UNIT 7 FUEL SCHEDULE**

Process Fuel Batch	U <sub>3</sub> O <sub>8</sub> Purchase (Conversion Start)	Enrichment Start	Fabrication Ending	Operation Start	Operation Ending
1A/1B					
2A/2B					
3A/3B					
4A/4B					
5A/5B					
6A/6B					

**Table A.3-7  
UNIT 8 FUEL SCHEDULE**

<b>Process Fuel Batch</b>	<b>U<sub>3</sub>O<sub>8</sub> Purchase (Conversion Start)</b>	<b>Enrichment Start</b>	<b>Fabrication Ending</b>	<b>Operation Start</b>	<b>Operation Ending</b>
1A/1B					
2A/2B					
3A/3B					
4A/4B					
5A/5B					
6A/6B					

**A.4 PROJECT SCHEDULE**

(Later)

**A.5 PLAN OF EXECUTION**

KECO intends to execute the project using the "components" approach for Project Implementation. With the "component" approach, project management, engineering and design of the plant, procurement of equipment and materials, construction management, installation, preoperational testing, startup and quality assurance will be the responsibility of KECO and an engineer-construction manager (EC).

Major equipment such as the NSSS and T/G will be purchased under firm price supply-only basis. Construction will be performed based on competitively bid, fixed price, and reimbursable subcontracts.

All engineering and design of the balance of plant, and procurement of equipment and materials including the condensing, feedwater, and extraction systems, as well as controls, piping, and pedestal work, will be performed by the EC organization. The erection and installation work will be managed by KECO and the EC, and carried out by local labor and subcontractors, with participation and support from the NSSS and T/G suppliers as necessary.

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Figure A.4-1  
Project Schedule (lotex)



## **A.5.1 KECO MANAGEMENT**

Under control of a KECO vice-president, three departments and one office handle the specialized activities involved in planning, construction, and operation of nuclear power plants.

Responsibilities of these and other departments involved in this project are as follows:

### **Nuclear Power Planning Department**

Manager of the Nuclear Power Planning Department has the following duties and responsibilities:

- Long-range nuclear power development program
- Type and unit size selection
- Technical and economic feasibility studies and loan application report
- Foreign financing
- Overseas procurement of permanent plant and other equipment and materials
- Fuel procurement in cooperation with Nuclear Power Generating Department
- Training of nuclear personnel

### **Nuclear Construction Department**

This department is charged with the following responsibilities:

- Coordination of project engineering and design activity with Engineer/Manager (and/or major contractor)
- Regulating flow of manpower and construction equipment during construction period
- Administrative and contractual procedures
- Coordination of jobsite and offsite project activities
- Design of foundation and certain civil structures
- Review of civil and architectural contracts by local contractors
- Equipment and shop drawing approval, and inspection and delivery expediting
- Planning and scheduling of overall project
- Review of power plant layout and design
- Review of equipment specifications

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### Nuclear Power Generating Department

This department has the following responsibilities:

- Operation and maintenance of nuclear power plants
- Legislative and regulatory procedure
- Nuclear safety and health physics
- Fuel management

### Quality Assurance Office

- Quality assurance
- Quality control

### Construction Site

The Superintendent of the Construction Site has the following responsibilities:

- Supervision of construction methods and unloading and lifting of heavy equipment
- Supervision of civil and architectural work performed by local contractors
- Field engineering and quality control
- Local procurement
- Jobsite administrative management
- Installation of mechanical and electrical equipment
- Quality assurance

### Transmission and Substation Department

This department has the responsibility for the design and construction of primary substations and transmission lines.

### Department of Estate and Environment

This department has the following responsibilities:

- Site study
- Land acquisition in cooperation with Property Custody Department

## A.5.2 ENGINEER-CONSTRUCTION MANAGEMENT

The EC Project Management Team will plan, organize, direct, and control project operations, and provide for participation and training of KECO and other Korean personnel.

Summary scope definition for the "component" approach is presented below under eight project groups:

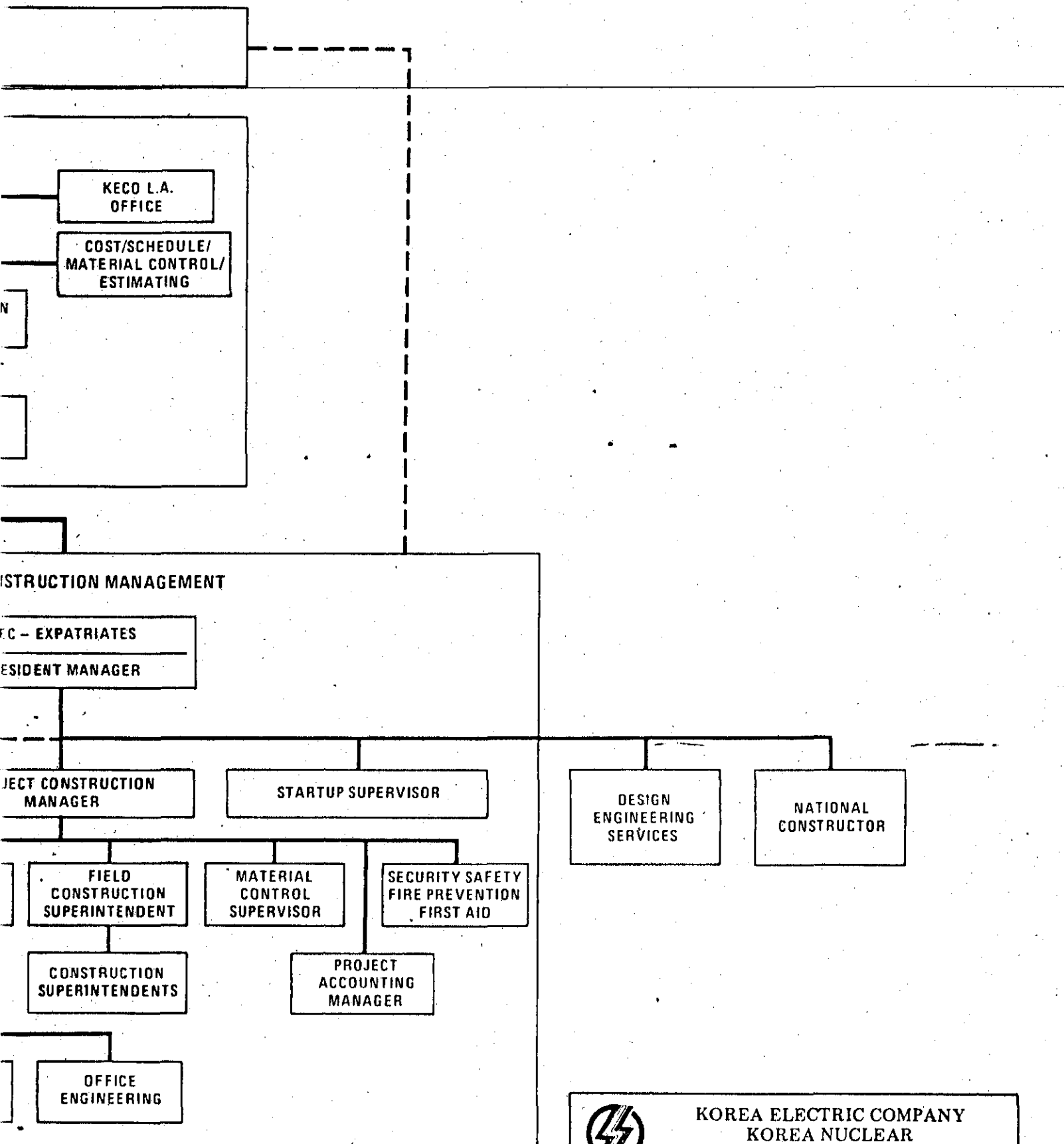
Project Management	Preoperational Testing and Startup Assistance
Engineering	Quality Assurance
Procurement	Cost/Schedule Services
Construction Management	Finance/Administration


### PROJECT MANAGEMENT

EC will provide management, consisting of planning, organizing, executing, supervising, coordinating, directing, and controlling the project. Acting together with the KECO Project Director, the Project Manager will monitor and direct the work to ensure that the required activities are implemented, budgeted, scheduled, and accomplished, and that adequate coordination and support are provided. A preliminary organization chart for the EC is given in Figure A.5-1.

To accomplish successful project completion, the Project Manager will participate in, and direct the following activities:

- Definition of the project scope and needed services consisting of the following elements:
  - Development of a Project Plan
  - Selection and implementation of a monitoring system that measures performance against the Project Plan
  - Selection of a reporting system that identifies deviations from the Project Plan
- Organization and staffing
- Project procedures preparation
- Contract definition and administration
- Coordination between KECO, EC, the Korean National Engineer, suppliers, and subcontractors



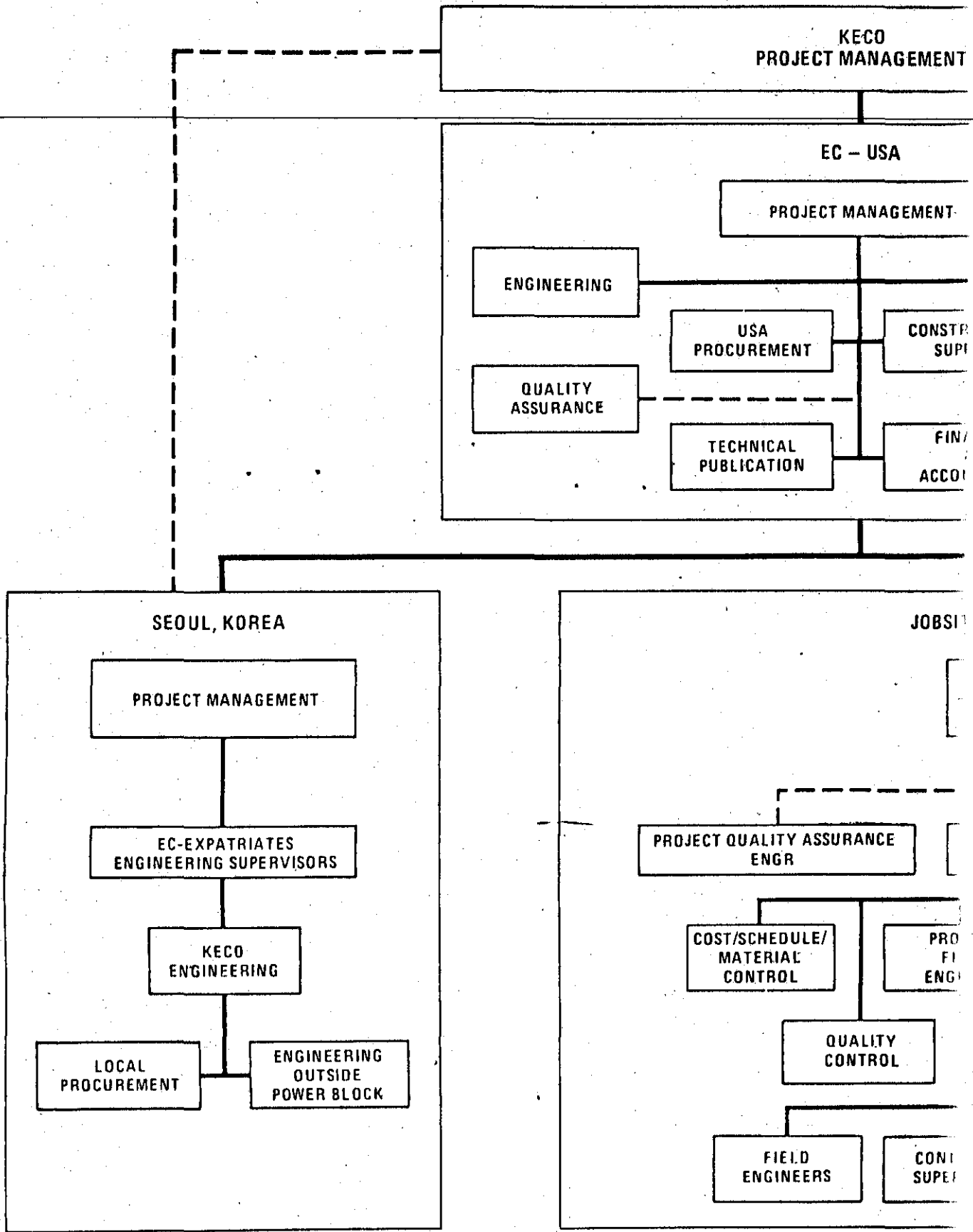


**KOREA ELECTRIC COMPANY**  
**KOREA NUCLEAR**  
**UNITS 7 & 8**

---

**ENGINEERING-CONSTRUCTOR ORGANIZATION**

Figure A.5-1



**LEGEND:**

- PROJECT DIRECTION
- - - -** REPORTING RELATIONSHIP

- Monitoring production aspects of the project (engineering, procurement, construction, startup and quality assurance)
- Review and approval of bid evaluations and procurement recommendations
- Reports to KECO and EC management

## ENGINEERING

The EC, as KECO's Engineer, will perform the planning, organizing, and executing of the design and engineering work for the Korea Nuclear Units 7 and 8.

The services to be performed comprise architectural, civil/structural, nuclear/environmental, mechanical, instrumentation and control systems, plant design, electrical engineering, and design work for the project.

The proposed broad division of engineering activities between the U.S. and Korean design office will be as follows:

### Principal activities in the U.S. Design Office

- Preliminary design of the power plant
- Detailed design engineering of the power block consisting of the following structures:
  - Reactor Building
  - Auxiliary Building
  - Fuel Storage Building
  - Turbine Building
  - Control Building
- Detailed design of the specialized structures: Diesel Generator Building and Radwaste Building
- Detailed design and engineering of Seismic Category I systems and structures outside the power block
- Preparation of specifications, bills of material, evaluation of bids, and support for procurement outside Korea
- Licensing support to KECO and preparation of licensing documents
- Planning and scheduling, quality engineering, cost engineering support, and preparation of project manuals

Principal Activities in the Korean Design Office (With the Korean National Engineer)

- Consultation on plant conceptual design for areas outside the power block
- Detailed design and engineering of non-Seismic Category I systems structures outside the power block
- Detailing of non-Seismic Category I small piping, supports and raceways in the power block
- Material takeoffs
- Preparation of specifications, bills of material, and evaluation of bids for procurement in Korea
- Liaison with KECO and construction at the jobsite
- Implementation of plans, schedules, quality engineering, cost engineering, support and project procedures as directed by Bechtel's Norwalk office
- Engineering support for construction and startup

PROCUREMENT

Procurement services to be provided for Korea Nuclear Units 7 and 8 will be conducted within a framework consistent with the defined scopes of work and tasks. All work performed will be in compliance with policies and procedures mutually agreed to with KECO.

The EC will provide procurement services encompassing the following activities:

- Purchasing of miscellaneous materials and equipment and the contracting of the more complex equipment and services
- Expediting of suppliers' efforts to assist suppliers in meeting contract schedules
- Quality surveillance to determine suppliers' with contractual quality requirements

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Bechtel's  
rep.

CONSTRUCTION MANAGEMENT

The EC will provide construction management services for Korea Nuclear Units 7 and 8 both in the U.S.A. and at the jobsite in Korea. Home office construction planning and scheduling will parallel the field activities in fully preparing the construction team for proper and timely commencement of site activities. The construction management team in Korea will organize, plan, and implement the overall field construction program.

## PREOPERATIONAL TESTING AND STARTUP ASSISTANCE

From job inception to commencement of field activities, the EC will provide direction and assistance to KECO in the preparation of the startup portion schedule, system test index, preoperational test procedures, detailed startup schedules, and monitoring of project design for cleaning and testing provisions.

KECO's operating staff will operate all permanent plant equipment and start up the plant with EC's assistance. A nucleus of experienced EC startup engineers will instruct KECO personnel in the home office and jobsite phases of the startup operation.

## QUALITY ASSURANCE

EC will provide the following quality assurance services for the Korea Nuclear Units 7 and 8:

- Review for conformance to quality assurance provisions in the safety analysis reports and the design criteria manual, and monitor the development and audit the implementation of the Project Quality Program Manual
- Conduct audits in the areas of engineering, procurement, and jobsite construction
- Review the Quality Control Instructions and all inspection planning applicable to site operations

## COST/SCHEDULE SERVICES

The EC will provide cost/schedule services for project control.

### COST CONTROL

Cost control services to be provided are: preparation of a project Code of Accounts and preparation of project estimates.

### SCHEDULE CONTROL

The following project schedules will be prepared and controlled during the course of the project:

- Milestone Summary Schedule. This is a total project schedule which includes engineering, procurement, construction and startup. The schedule establishes the constraints for all other project schedules.



- PSAR and FSAR Schedules.
- Engineering Detailed Schedule which defines the interdiscipline activities and construction interfaces.
- Construction Detailed Schedule
- Construction Contract Bid Package Schedules
- Contractor's Performance Schedules
- Six-Month Rolling Schedule
- Startup Summary Schedule
- Startup Detailed Schedule

### MATERIAL CONTROL

Equipment and bill of material reports, which show quantities, and procurement and construction status, will be prepared. These reports will be prepared for the following commodities:

- Piping, hangers, and valves
- Electrical items including wire and cable, connections, trays and conduits, and equipment
- Civil/structural items including forms, rebar, embedded metal, and concrete
- Mechanical equipment
- Instrumentation

### FINANCE/ADMINISTRATION

~~The EC~~ will provide finance and administration services in Korea and in the U.S.A. as described below.

#### Services in Korea

The following finance and administration services will be provided in Korea:

- Maintenance of all accounting records and preparation of financial reports
- Preparation of billings for compliance with contract terms and for transmittal to KECO

## Services in the U.S.A.

Home office administrative support will consist of:

- Support to Cost/Schedule in maintaining records and providing data
- Analyses of financial information, estimates of administrative costs and schedules, preparation of financial forecasts, and cost records
- Assistance to subcontractors and vendors by providing cost data, monitoring progress payments, and processing claims

### A.5.3 PLANNING

A considerable amount of preparatory work has been carried out, including preliminary site studies, economic and power forecast studies, preparation of request for bids, evaluation of bids, and selection of suppliers for the NSSS and T/G. Overseas Bechtel Incorporated was engaged to supply the following services:

- Prepare and issue bidding documents for nuclear steam supply system, nuclear fuel, and turbine-generator on component basis, and for nuclear island and conventional island on an island basis.
- Establish with KECO the basis for evaluation of the bids. Screen and evaluate the nuclear steam supply system, nuclear fuel, and turbine-generator proposals on a component basis and the nuclear island and conventional island proposal.
- Provide technical assistance during negotiation and preparation of contracts with suppliers.
- Assist in preparation of the Financial memorandum "Loan Application" for Korea Nuclear Units 7 and 8 and prepare nuclear plant cost data and economic data.
- Prepare the overall Project Quality Program Plan, which covers quality assurance requirements for the design, fabrication of components, construction, startup, and operation of nuclear power plants.
- Review survey reports made by others regarding Korean manufacturing industries that identify Korean suppliers capable of producing materials and equipment for the Korea Nuclear Units 7 and 8, and prepare a survey plan to investigate the "long-term" potential capability of Korean manufacturing industries to support the proposed Korean Nuclear Power Program.

*Almost total dependence on Bechtel. How does Bechtel do it. w/ this in all*

- Review the organization and management pattern of KECO and prepare, with assistance from KECO, the preliminary outline of the Project Procedures and the Division of Responsibility for exercising control over Project Implementation.
- Undertake planning and preliminary work to identify critical areas associated with Project Implementation.

## A.6 PROJECT OPERATION

KECO plant operation is carried out by the Nuclear Generating Department. This department consists of eight sections: one provides instrument maintenance; five provide actual plant operation; one provides training; and one provides general support services.

(Later)

BY KECO

APPENDIX B  
KOREA ELECTRIC COMPANY

**B.1 HISTORY**

Korea Electric (KECO) was established on July 1, 1961 as a merger of Korea Electric Power Company, Seoul Electric Company, and South Korea Electric Company, and placed under supervision of the Ministry of Energy and Resources (MER). KECO is the only electric power utility in Korea; as such, it is responsible for all aspects of developing, supplying, and marketing electric power. With the exception of two industrial organizations, which own 8.9% (as of 1978) total generating capacity, KECO provides all electric generating capacity for Korea. However, all distribution is provided by KECO, including surplus capacity from these other sources.

Electric power in Korea predates this merger by 63 years, with the founding of Honsung Electric Company in 1898 by two Americans, H. Collbran and H. R. Bostwick. The company name was changed to Seoul Electric Company in 1915. South Korea Electric Company resulted from a series of consolidations starting in 1918. Korea Electric Power Company was formed from a series of mergers in 1943.

Korea had a total capacity of 1700 MW when liberated from Japan in 1945, but with 88% under control of the North. The outmoded 200 MW of plant capacity in the South, added to an average of 60 MW supplied from the North (arbitrarily discontinued in 1948), coupled with complete disruption during and after the Korean War (1950 to 1953), served as a weak base for expansion of desperately needed electric power capacity until after formation of KECO in 1961.

Starting with total capacity of 367 MW, KECO has successfully carried out three five-year power development plans, leading to a total capacity at the end of 1978 of 6916 MW (including 615 MW supplied by others). This greatly expanded system has helped support a rapidly expanding economy, but is still lagging behind present and expected future demand with adequate reserve capacity.

To cope with the growing load requirement of the near future, KECO has formulated a 10-year power development program (detailed in two 5-year plans) for acquisition of new generating capacity, part of which is presently under construction, with the remainder under active study and implementation. Nuclear Units 7 and 8 scheduled for commercial operation in 1986 and 1987, respectively, are among the most important projects of this future program.

## **B.2 REGULATORY ENVIRONMENT**

The merger which formed KECO was decreed by the Korea Electric Company Act (No. 639, dated June 23, 1961) and effected by adoption of a Charter (The Korea Electric Company Charter). Under the terms of the KECO Act and its accompanying Decree (No. 762, dated May 21, 1962), the Ministry of Commerce & Industry (MCI) was given broad power over KECO. Directions for the use of these powers are defined in the Electric Enterprise Act. The advent of nuclear power has brought about special regulatory actions.

### **B.2.1 THE KOREA ELECTRIC COMPANY ACT**

The KECO Act deals principally with management and control of KECO. Nine directors and one auditor are elected by the shareholders and approved by MCI, with a President and Vice-President chosen from among the Directors by MCI, and approved by the President of the Republic of Korea. Certain accounting practices are provided, such as revaluation of assets under the terms of the Assets Revaluation Law. MCI, subject to approval in certain cases of the Ministry of Finance, shall exercise the Government's right to direct the development of electric power resources, and establish terms and conditions of supplying energy to users.

### **B.2.2 THE ELECTRIC ENTERPRISE ACT**

Controlling functions given to MCI under terms of the KECO Act are supplemented by provisions in the Electric Enterprise Act. Electric enterprises, or those wishing to engage in generating and supplying electricity, must submit to the authority of MCI. MCI has power to approve, alter, regulate, and direct the activities of electric enterprises, particularly in such fields as generation, supply, and pricing electricity; planning of future generating capacity; and establishment of safety standards. MCI has authority over KECO's activities, approves its advance plans and annual budgets, sets accounting standards (in conjunction with the provisions of the KECO Act), and audits KECO operations.

### **B.2.3 THE KOREA ELECTRIC COMPANY CHARTER**

The Charter established KECO and declared its purpose to be development of electric power resources; generation, transmission, and distribution of electric power; and conduction of various related business operations, such as manufacture and supply of gas, provision of electric railway services, and manufacture, sale, and lease of electric and gas appliances. The Charter also established, among other things, the rights of stockholders, procedures at meetings, and the power and duties of officers and directors.

## B.2.4 NUCLEAR POWER ACTS AND REGULATORY AGENCIES

The Atomic Power Generation Corporation Law, which establishes a corporation independent of KECO to carry on the business of planning, construction, and operation of nuclear power plants, was passed by the National Assembly on April 4, 1975. The Atomic Power Generation Corporation has the authority to assume from KECO the assets and liabilities relating to construction of nuclear plants, and the rights and duties under contracts relating to construction and operation of plants.

So far, however, the Presidential Decree, which will establish the date of this law's implementation and supplement its provisions, has not been issued. There are understood to be no immediate plans for publication of such a decree.

A regulatory agency, the Republic of Korea Atomic Energy Committee (ROK-AEC) was formed in March, 1967. The committee is responsible for supervision and regulation of atomic and nuclear research and all nuclear installations in Korea. The Committee promotes development of nuclear science and technology, as well as peaceful applications of nuclear energy in various fields. The Committee also assures that safety standards are maintained at nuclear installations and oversees any public or private agencies concerned with safeguarding human life and property.

The ROK-AEC consists of nine members, each of whom is a representative of the Ministry of Science and Technology or another government agency whose functions are related to development of nuclear energy. The Committee's functions include not only establishing general policy for the national nuclear programs, but also coordination of activities connected with nuclear energy. For example, ROK-AEC may represent Korea on matters related to the bilateral agreement concerning civil uses of nuclear power between Korea and the USA, as well as the agreement concerning cooperation in peaceful uses of nuclear energy.

The Ministry of Science and Technology (MOST) carries out its regulatory responsibilities through the granting of construction permits and operating licenses for nuclear plants, but only after a thorough review of proposed designs and operational procedures. Additionally, construction, fabrication, testing, and operational activities are continuously monitored, and use, storage, and transfer of nuclear material and fuel are inspected. An audit is made of insurance, or other types of financial protection, for nuclear damage liabilities, to assure compliance with regulations.

The Atomic Energy Law of the Republic of Korea became effective on March 11, 1958, and has been amended as required to keep it current. Additionally, other rules and regulations covering nuclear liability, site selection, radiation protection standards, material transport, special nuclear material, mines and ores, and licensing have been enacted. These are similar to rules and regulations issued by IAEA and the USNRC.

In summary, KECO operates within certain governmental authorization and central procedures for conduct of its business activity, and well defined rules and regulations on nuclear power.

### B.3 OWNERSHIP

KECO is, at the present time, a mixed private and public corporation, with the following (as of December 31, 1978) distribution of ownership:

Government	82.09%
Institutions	7.38%
Individual	10.52%
Foreigners	0.01%

An amendment of the Korea Electric Company Act, effective December 31, 1976, called for purchase by the Government of all shares before the end of 1981, thereby changing KECO into a 100% government invested corporation. This will enable the Government to inject large sums of capital into KECO and employ its powers of control over KECO without concern of possible conflict of interest with private stockholders. At the same time, it can establish a suitable financial structure for the expansion plans envisaged in KECO's Long-Range Power Development Program.

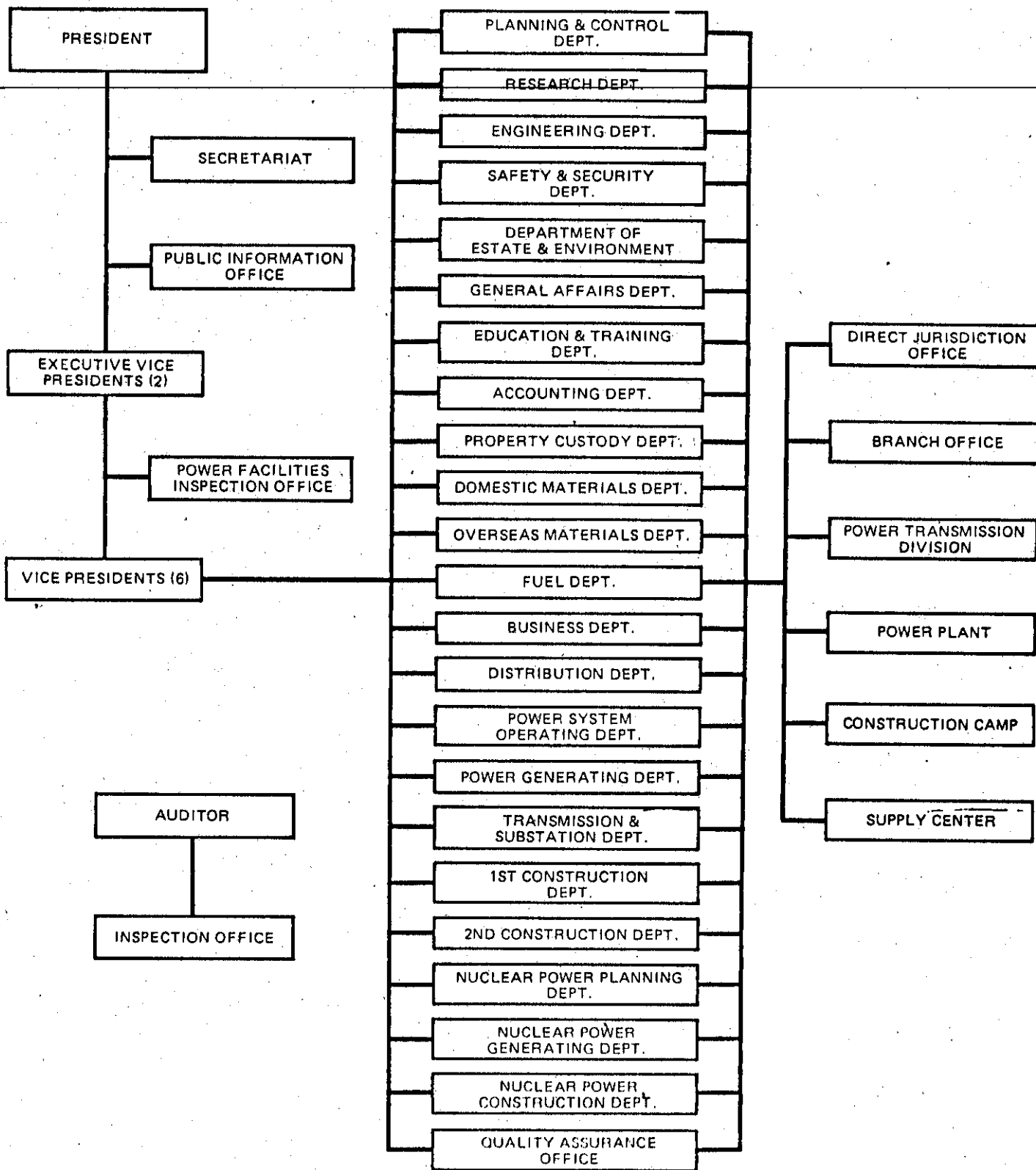
### B.4 MANAGEMENT


According to the KECO Act previously described, there are currently eight directors elected by the shareholders and approved by Ministry of Energy and Resources, with the President subject to approval by the President of the Republic of Korea and Ministry of Energy and Resources. The present members of the Board of Directors are as follows:

- Kim, Yung Joon, Chairman and President
- Sung, Nack Chung, Executive Vice President
- Kang, Tae Hong, Executive Vice President
- Lee, Kyo Sun, Vice President
- Kim, Yeong Kwon, Vice President
- Kim, Sun Chang, Vice President
- Seung, Nak Sang, Vice President
- Suh, Jheng Oh, Vice President
- Park, Tong Joung, Vice President

The KECO auditor is Mr. Lee, Nam Joo.

KECO organization is shown in Figure B.4-1.




**KOREA ELECTRIC COMPANY**  
**KOREA NUCLEAR**  
**UNITS 7 & 8**

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**KECO ORGANIZATION**  
**FIGURE B,4-1**



## B.5 SERVICE AREA

KECO's service area includes the entire Republic of Korea, an area of approximately 98,810 square kilometers, with a population of 36,600,000. Population centers are primarily in the northwest and southeast portions of the country, with approximately one-fifth of the people in Seoul. Table B.5-1 shows regional maximum power consumption.

KECO headquarters are in Seoul. Twenty-one sales districts and 442 service centers are distributed throughout Korea to effectively serve all customers.

Table B.5-1  
REGIONAL MAXIMUM POWER CONSUMPTION

District	December 21, 1978 (%)
Kyung-In (Northwest)	41
Yong-Dong (Northeast)	10
Ho-Nam (Southwest)	13
Yong-Nam (Southeast)	36

## APPENDIX C THE REPUBLIC OF KOREA

### C.1 GENERAL

Korea is a strategically important country which has served as a cultural and land bridge between Asia and Japan since before 57 BC, the date of its earliest written records. Following an isolationist period in the latter half of the Yi Dynasty – between the late 16th and early 20th centuries – the country was under Japanese rule from 1910 until 1945. Subsequent to the Allied victory in World War II, Korea was divided along the 38th parallel. Japan surrendered the southern half of the peninsula to the U.S.A. and the north to the U.S.S.R. The south became the Republic of Korea (South Korea) and the north became the so-called People's Democratic Republic of Korea (North Korea).

In 1948 free elections were held in the south, and on August 15, 1948, the Republic of Korea was established. In the same year the U.N. General Assembly declared the Republic of Korea to be the only legal government on the peninsula.

In 1950 North Korea attacked South Korea. The United Nations came to South Korea's defense.

In July, 1953, an armistice agreement was reached that established a demilitarized zone along the military cease-fire line in the general vicinity of the 38th parallel. This demilitarized zone now forms the border between Korea and North Korea.

### C.2 GEOGRAPHY

The major portion of the Korean peninsula is located within latitudes 34 and 42 north and longitudes 125 and 130 east. The peninsula is approximately 1,000 km (600 miles) long and 225 km (135 miles) wide. The total land area is approximately 219,295 sq km. (78,968 square miles). It is bounded by the Yellow Sea on the west and the East Sea (Sea of Japan) on the east.

The Republic of Korea comprises the southern half of the Korean peninsula lying generally below the 38th north parallel and occupying approximately 98,757 sq km (35,562 square miles). The land is generally mountainous on the east coast and gradually slopes to hills and valleys on the west coast. Approximately 23% of the Republic is arable, the remainder being newly reforested pine woods or scrub. The temperature averages -2.5 C (27.5 F) in the winter and 24.3 C (75.7 F) in the summer with humidity of 65 percent and 82 percent, and precipitation of 16.7 mm/month (0.07 in./month) and 155.9 mm/month (0.61 in./month), respectively.

### C.3 POPULATION AND CULTURE

During the 4,000 years since the ancestors of the Korean people migrated from Central Asia, the Korean people have developed a unique, homogeneous culture. The language is related to the Ural-Altaic group and bears no similarity to Chinese or Japanese. The Korean alphabet, Hangeul, is a phonetic system created by a Korean royal commission in the 15th century; however, until 1910, all official documents were written in Chinese characters.

Korean is a unique mother language in Korea and English is the first foreign language in educational courses.

As the court religion during the Yi Dynasty (1392-1910), Confucianism is the creed most pervasive in modern Korean life. Buddhism (introduced in the fourth century AD) and Christianity (introduced in the 17th century) each have slightly over four million followers which also play a major role in the religious life of the country.

At mid year 1978, the Republic had a population estimated by the Government at 36.6 million with a rate of increase of approximately 1.6% and a population density of 371 per sq km (1,008 per sq mi). Over 40 percent of the population lives in cities which, in order of size, include Seoul (the Republic's national capital) 7.8 million, Pusan (the Republic's largest port) 2.9 million, Taegu 1.5 million, and Incheon 0.9 million.

By Government estimate, the economically active population in the Republic is 13,440,000 with 12,929,000 actually employed in December 1977. The composition of employment by general categories is: agriculture, forestry and fisheries (41.8%); mining and manufacturing (22.4%); social and other services (35.8%); with mining and manufacturing being the major growth sector.

The literacy rate of the population over six years of age exceeds 90 percent.

### C.4 GOVERNMENT

The Republic of Korea is a democratic republic governed under a constitution established on July 17, 1948 and several times amended. The constitution acknowledges the sovereignty of the people and establishes the President as the head of state, chief executive officer of the Government, and commander in chief of the armed forces.

Since establishment of the constitution, there have been four republics. The First Republic (1948-1960) was governed by the successive administrations of Dr. Syngman Rhee. In response to student riots in April 1960, Dr. Rhee resigned and on June 15, 1960, the nation amended the constitution to change its Government into a cabinet system headed by Prime Minister John Chang (The Second Republic 1960-1961). In May 1961, the constitution was temporarily suspended when military leaders headed by Major General Chung Hee Park

assumed power. On December 26, 1962, the constitution was amended and a new civilian government was established which began the Third Republic. General Park was elected President in October 1963. Under the provisions of the constitution and subsequent elections, President Park has remained as the Presidential incumbent since that time (The Third Republic 1962-1972). On December 27, 1972, the constitution was amended by referendum to provide for presidential power and responsibility for achieving peaceful unification of the fatherland, which began the Fourth Republic.

Under the amended constitution, the President, in addition to his other responsibilities, is Chairman of the National Security Council. ~~He has the power to veto new legislation, declare war, conclude peace, ratify treaties, dissolve the National Assembly, and issue emergency decrees.~~ In 1974, President Park issued four emergency decrees which were either superseded by legislation or revoked in the same year.

The President also exercises administrative control over the Government in his role as ~~Chairman of the State Council.~~ The State Council consists of between 15 and 25 members appointed by the President with the Prime Minister as Vice Chairman. The executive ministries include: the Economic Planning Board and the Ministries of Foreign Affairs, Home Affairs, Finance, Justice, Defense, Education, Agriculture and Fisheries, Commerce and Industry, Energy and Resources, Construction, Health and Social Affairs, Transportation, Communication, Culture and Public Information, Government Administration, Science and Technology, and Unification Board.

One of the constitutional changes incorporated in the 1972 amendment was the creation of a National Conference for Unification (NCU) which is elected by popular vote for a six-year term coincident with that of the President of the Republic. This body is chaired by the President and — in a manner similar to the U.S. electoral college — this, 2,581 member body elects the President. In addition, the NCU elects one-third of the national legislature (National Assembly) for a three-year term from a slate of candidates submitted by the President.

The Constitution vests legislative power in a unicameral body — the National Assembly. The National Assembly is currently comprised of 231 representatives, one-third of which are elected for three-year terms by the NCU; the remaining two thirds are elected by popular vote of the people for six-year terms. Both the members of the National Assembly and the President are empowered to introduce bills. In addition, the President formulates and submits the annual budget bill to the National Assembly for deliberation and approval 90 days before the beginning of the fiscal year. The National Assembly further has the right to consent to the ratification of pacts pertaining to mutual assistance or mutual security, treaties of commerce, or treaties regarding the disposition of Korean troops to foreign lands or alien troops in Korea, as well as the right to consent to the declaration of war. In the event of Constitutional violations by the President, Prime Minister, the State Council, Heads of Executive Ministries, Judges, or other public officials designated by law, the National Assembly has the power to impeach.

The judicial power of the land is vested in the Supreme Court and other courts at various levels. As the highest court of the State, the Supreme Court has the final power to review the constitutionality or legality of laws, administrative decrees, regulations, or dispositions when their constitutionality or legality is a prerequisite to a trial. The Supreme Court is composed of 16 judges including the Chief Justice. The Chief Justice is appointed by the President and confirmed by the National Assembly. Other Supreme Court Justices are nominated by the Chief Justice and appointed by the President.

The Constitution also establishes a Constitution Committee consisting of nine members appointed by the President (three nominated by the National Assembly, and three nominated by the Chief Justice). The Constitution Committee has the power to rule on the constitutionality of a law upon request of the Supreme Court, impeach public officials, and dissolve political parties.

#### **C.4.1 LOCAL GOVERNMENT**

Local Government in the Republic is achieved through nine provinces and two cities with provincial status. Local government is directed by the Central Government with key officials being appointed by the President.

#### **C.4.2 POLITICS**

There are two primary political parties in the Republic, the Democratic Republican Party (DRP), and the New Democratic Party (NDP). Of the 154 National Assembly seats which are filled by popular vote, the DRP holds 44 percent, NDP holds 40 percent, and other minority parties hold 16 percent.

President Park is the Chairman of the Democratic Republican Party. The DRP is assured of a majority in the National Assembly by virtue of the fact that the members of the National Assembly elected by the National Conference for Unification are aligned with the DRP.

#### **C.4.3 FOREIGN RELATIONS**

The preamble to the Constitution of the Republic of Korea sets forth two general foreign policy goals: (1) to strive to maintain world peace internationally, and (2) peaceful unification of the fatherland. The power and responsibility for achieving these results is vested in the President.

In working toward these goals, the Republic has developed diplomatic and economic relationships with most nations of the non-communist world. It is currently in the process of expanding economic relationships with the communist world. The Republic maintains membership in a number of international organizations including the Asian Development Bank, the International Bank for Reconstruction and Development, the International Monetary Fund, and is a party to the General Agreement on Tariffs and Trade. While South Korea

is not a member of the United Nations, it is a member of specialized agencies such as ESCAP, FAO, UNCTAD, UNESCO, and WHO.

## C.5 THE ECONOMY

The Republic of Korea has a private, free market economy. Since 1962, the Government has been directly involved in establishing economic policy objectives through the vehicle of five-year plans (1962-1966, 1967-1971, 1972-1976, 1977-1981). These plans are created by the Economic Planning Board — presently headed by the Deputy Prime Minister — and are implemented through Government fiscal policy as well as ministries (and regulatory bureaus) and the banking system. Tools for implementation include, among other tax incentives, favorable terms and interest rates on developmental loans from special purpose banks such as the Korea Development Bank, and import quotas to protect infant industries.

### C.5.1 GROSS NATIONAL PRODUCT

Since initiation of the five-year economic plans, the Republic has experienced economic development and GNP growth rates that have been among the highest of all non-oil producing developed or developing countries. Real rates of growth averaged 7.7 percent in 1962-66, 10.5 percent in 1967-71, and 12.1 percent in 1972-76, the latter being achieved during the period when oil prices quadrupled and recession hit the world's developed economies.

Real per capita GNP has grown as well. In 1971 real GNP in 1975 dollars was \$390 versus \$771 in 1978. It is important to note that the expansion of per capita GNP has been more equitably distributed in Korea than in most developing countries. During the early years of economic planning (1962-1971) more emphasis was given to expanding the import substitution industries; hence wages and the standard of living in manufacturing households rose more rapidly than those in agricultural communities. With introduction of the Saemaul Undong (New Community Movement) by President Park in the early 1970's, more emphasis was placed on increasing the income and standard of living of agricultural families. During the period 1970-1977 monthly income of urban families rose by 269 percent to approximately W 117,090 while income of agricultural families rose by 460 percent to approximately W 119,400. Because farm families are larger than urban families, per capita income has not yet reached parity.

To sustain this high economic growth, a large portion of GNP has been invested in fixed capital formation. From 1967 to 1976, real gross investment increased at a rate of 15 percent while its share of GNP averaged 26 percent over the same period. This figure compares well with other developing countries.

The source of investment funds has also shifted over the years. In the early 1960's — prior to the August 3, 1966 enactment of the Foreign Capital Inducement Act — foreign savings comprised mainly grants and soft loans from foreign governments and international organizations. Since the early 1970's, commercial loans and direct investment have become an

Table C.5-1  
GROSS NATIONAL PRODUCT  
(In billions of won at current market prices)

Item	1971	1972	1973	1974	1975	1976	1977	1978
Private Consumption	2,337	2,844	3,339	4,703	6,424	8,507	10,400	13,622
Public Consumption	356	438	479	742	1,020	1,499	1,989	2,579
Gross Domestic Fixed Capital Formation	730	780	1,169	1,755	2,332	3,152	4,421	6,978
Increase in Inventories	76	25	119	347	147	219	225	72
Exports of Goods and Services	514	814	1,578	2,071	2,748	4,359	5,967	7,585
Less Imports of Goods and Services	(866)	(1,014)	(1,740)	(2,916)	(3,613)	(4,595)	(5,967)	8,264
Errors and Omissions	7	(13)	(6)	111	180	(6)	(280)	(268)
Expenditure on Gross Domestic Product	3,154	3,875	4,939	6,813	9,239	13,135	16,754	22,305
Net Factor Income from the Rest of the World	(2)	(15)	(37)	(66)	(159)	(84)	(101)	(49)
<b>TOTAL GNP</b>	<b>3,152</b>	<b>3,860</b>	<b>4,902</b>	<b>6,747</b>	<b>9,080</b>	<b>13,051</b>	<b>16,652</b>	<b>22,256</b>
Gross National Product at Constant 1975 prices	6,217	6,650	7,712	8,381	9,080	11,016	12,175	13,693
Percentage Increases of GNP Over Previous Year:								
At Current Prices		22.5%	27.0%	37.6%	34.6%	43.7%	27.6%	33.7%
At Constant Prices		7.0%	16.0%	16.7%	8.3%	21.3%	10.5%	12.5%
Population (000's)	32,882	33,505	34,103	34,692	35,281	35,860	36,436	36,629
Per Capita GNP								
(A) At Current Prices (Won)	95,844	115,207	143,730	194,485	257,372	363,943	457,021	607,606
Percent Change from Previous Year		20.2%	24.8%	35.3%	32.3%	41.4%	25.6%	32.9%
(B) At Constant Prices (Won)—(1975)	189,038	198,438	226,155	241,572	257,362	307,195	334,148	373,829
Percent Change from Previous Year		5.0%	14.0%	6.8%	6.5%	19.4%	8.8%	11.9%

Source: Bank of Korea, Monthly Economic Statistics Volume XXX No. 9, and Vol. XXXIII Nos. 1 and 7.

increasing and now major component of foreign savings invested in Korea. Nevertheless, domestic savings represent the major and expanding portion of investment in Korea. In 1962, domestic savings amounted to no more than 2 percent of GNP and 12 percent total investment. In fact, they were probably not sufficient even to cover depreciation of existing capital stock. However, they rose rapidly thereafter, and the share of domestic investment which they financed amounted to roughly 54 percent in 1966, 57 percent in 1971, and 90 percent in 1976.

During the 15 years since economic planning began, the structural origin of the Republic's GNP has changed substantially. The structure of production in 1961 was similar to that of most economies in the early stage of economic development with primary industry (agriculture, fisheries, and forestry) accounting for approximately 40 percent of production. Since Korea had a limited amount of arable land and scarce mineral resources, it became clear that it could not depend on the primary sectors to provide the foreign exchange surplus needed for rapid economic development. Instead, the Republic emphasized the development of the manufacturing sector which has grown at an average rate of 18.3 percent during the 15 years of economic planning. In 1976, this sector accounted for approximately one third of GNP. During this same period, the composition of industrial production shifted from light industry toward the capital stock, chemical, and heavy industries. In 1976, these latter industries accounted for about one third of industrial production.

### C.5.2 BALANCE OF PAYMENTS

As the economy expanded rapidly after 1961, exports and imports also expanded with a favorable change in the ratio of exports to imports (on an f.o.b. basis) from 36.8 percent in 1966 to 85.3 percent in 1973. This favorable trend reversed when the fourfold oil price increase as of late 1973-1974 was implemented. As a result of the oil price and related increases in the prices of primary imported commodities, the trade deficit rose from \$566 million in 1973, to \$1,937 million in 1974, and \$1,671 million in 1975. In 1975, the current account deficit of \$1,887 million was financed primarily by capital inflows into the private sector, whereas in the previous year, the \$2,023 million deficit was financed by increased public and private sector external borrowing.

It should be noted that the trade deficits in the first and second halves of 1975 were substantially different. In the first half of the year, the trade deficit amounted to \$1,458 million. This shrank to a deficit of \$213 million in the second half as the economies of the developed countries recovered (causing exports to increase) and as the effects of the oil price increases washed through the system.

### C.5.3 FOREIGN EXCHANGE RESERVES

The Republic's official foreign exchange reserves totalled \$4,306,365,000 at December 31, 1977, which is equal to 4.8 times average monthly imports in 1977. At December 31, 1978, foreign exchange reserves totalled \$4,937,100,000—equal to 4.0 times average monthly imports in 1978.



Table C.5-2  
INDUSTRIAL ORIGIN OF GNP

Industry	(In billions of won)								Percent of GNP		
	1961	1972	1973	1974	1975	1976	1977	1978	1961	1975	1978
Primary Industries:											
Agriculture, Forestry, & Fishery	119	1,095	1,255	1,687	2,303	2,972	3,581	4,718	40.2	25.4	21.2
Secondary Industries:											
Mining & Quarrying	6	38	48	71	117	163	249	323	1.9	1.3	1.4
Manufacturing	40	903	1,290	1,892	2,581	3,662	4,594	5,947	13.4	28.4	26.7
Construction	10	179	238	303	416	673	1,082	1,959	3.2	4.6	8.8
Tertiary Industries:											
Electricity, Water, & Sanitary Services	3	76	85	76	123	181	261	321	1.2	1.3	1.4
Transportation, Storage, & Communications	14	223	299	390	511	788	1,017	1,325	4.6	5.6	6.0
Wholesale & Retail Trade	33	648	904	1,257	1,636	2,417	2,954	3,756	11.2	18.0	16.9
Banking, Insurance, & Real Estate	4	87	108	165	225	440	614	880	1.4	2.5	4.0
Ownership of Swellings	17	84	95	126	164	318	419	560	5.6	1.8	2.5
Public Administration & Defense	20	199	214	289	396	575	785	1,004	6.9	4.4	4.5
Services	28	343	402	557	767	948	1,197	1,512	9.5	8.4	6.8
Rest of the World	3	(15)	(37)	(66)	(159)	(84)	(101)	(49)	(0.9)	(1.7)	(0.2)
GNP at Current Market Prices	297	3,860	4,901	6,747	9,080	13,051	16,652	22,256	100.0	100.0	100.0

Source: The Bank of Korea, Monthly Economic Statistics, Vol. XXX Nos. 1 and 9, and Vol. XXXIII No. 7

Table C.5-3  
BALANCE OF PAYMENTS

The following table indicates the Republic's balance of payments for the years 1972 to 1978.  
(In millions of dollars)

Item	1972	1973	1974	1975	1976	1977	1978
<b>1. Current Account</b>							
Trade Balance <sup>(1)</sup>	(574.5)	(566.0)	(1,936.8)	(1,671.4)	(590.5)	(476.6)	(1,813.4)
Freight and Insurance	(125.3)	(247.6)	(333.8)	(195.1)	(152.0)	(61.6)	(154.8)
Other Transportation	14.5	12.3	6.5	(47.1)	(115.4)	(260.1)	(383.2)
Travel	62.1	247.0	125.7	109.9	228.8	267.3	200.1
Investment Income	(139.7)	(172.5)	(241.7)	(404.1)	(446.8)	(593.8)	(682.6)
Government Transactions	200.4	140.8	117.5	85.7	132.2	174.1	
Other Services	21.5	87.1	30.5	8.5	281.4	740.1	1,277.8
Balance of Goods and Services	<u>(541.0)</u>	<u>(498.9)</u>	<u>(2,245.1)</u>	<u>(2,113.6)</u>	<u>(662.3)</u>	<u>(210.6)</u>	<u>(1,556.1)</u>
Private Transfers	119.2	155.1	153.8	159.2	195.8	170.5	—
Public Transfers <sup>(2)</sup>	50.6	35.0	68.6	67.5	152.9	52.4	—
Balance of Transfers	<u>169.8</u>	<u>190.1</u>	<u>222.4</u>	<u>226.7</u>	<u>348.7</u>	<u>222.9</u>	<u>471.6</u>
Balance of Current Account	<u>(371.2)</u>	<u>(308.8)</u>	<u>(2,022.7)</u>	<u>(1,886.9)</u>	<u>(313.6)</u>	<u>12.3</u>	<u>(1,084.5)</u>
<b>2. Capital Account</b>							
Private	247.6	472.1	786.8	1,804.6	1,149.3	833.0	—
Public	311.2	(66.1)	940.6	(10.6)	(383.5)	(563.8)	—
Other Monetary Institutions <sup>(3)</sup>	(228.9)	(116.0)	267.4	311.3	(211.7)	(249.8)	—
Balance of Capital Account	<u>329.9</u>	<u>290.0</u>	<u>1,994.8</u>	<u>2,105.3</u>	<u>554.1</u>	<u>19.4</u>	<u>1,176.3</u>
<b>3. Errors and Omissions</b>	<u>41.3</u>	<u>18.8</u>	<u>27.9</u>	<u>(218.4)</u>	<u>(240.5)</u>	<u>(31.7)</u>	<u>(91.8)</u>

(1) Calculated on an f.o.b. basis.

(2) Credits cover various official foreign aid and grants received.

(3) Included are Korea Exchange Bank, other banks engaging in foreign exchange business, and branches of foreign banks in the Republic.

Source: The Bank of Korea, Monthly Economics Statistics, Vol. -XXXIII No. 7

Table C.5-4  
BALANCE OF PAYMENTS PROJECTIONS<sup>(1)</sup>  
(In millions of U.S. dollars at 1975 prices)

Item	1976	1977	1978	1979	1980	1981
Exports	6,750	8,248	9,692	11,194	12,705	14,165
Imports	7,841	9,023	10,157	11,343	12,573	13,826
Trade Balance	(1,019)	(775)	(465)	(149)	132	339
Receipts	1,295	1,677	2,086	2,448	2,879	3,344
Payments	1,654	2,071	2,490	2,840	3,262	3,660
Services Balances	(359)	(394)	(404)	(392)	(392)	(396)
Transfers Net	226	211	203	194	182	169
Balance of Current Account	<u>(1,224)</u>	<u>(958)</u>	<u>(666)</u>	<u>(347)</u>	<u>(78)</u>	<u>192</u>
Loans and Investment	1,481	1,855	2,032	2,087	2,094	1,932
Amortization	(366)	(489)	(579)	(658)	(737)	(787)
Exports on Credit	(89)	(227)	(321)	(402)	(526)	(646)
Others	76	1	(44)	(84)	(116)	(136)
Long Term Capital (Net)	<u>1,102</u>	<u>1,140</u>	<u>1,088</u>	<u>943</u>	<u>715</u>	<u>363</u>
Basic Balance	<u>(122)</u>	<u>182</u>	<u>422</u>	<u>596</u>	<u>637</u>	<u>555</u>
Short Term Capital (Net)	241	81	(40)	(150)	(193)	(217)
Bank Borrowings (Net)	189	(21)	(326)	(447)	(466)	(398)
Change in FX Holdings	756	476	388	387	410	413
Korean FX Holdings	2,298	2,774	3,162	3,548	3,958	4,371

(1) On a c.i.f. basis.

Source: Major Economic Indicators of The Fourth Five Year Economic Development Plan (1977-1981), 1976 Economic Planning Board.

Table C.5-5  
OFFICIAL FOREIGN EXCHANGE RESERVES

(In thousands of U.S. dollars)

Item	As of December 31							
	1971	1972	1973	1974	1975	1976	1977	1978
Gold <sup>(1)</sup>	3,459	4,050	4,636	4,653	4,702	4,730	6,183	29,706
Foreign Exchange	534,501	693,801	1,034,159	1,049,345	1,541,555	2,948,078	4,288,300	4,879,331
Total Gold & Foreign Exchange	537,960	697,851	1,038,795	1,053,998	1,546,257	2,952,808	4,294,483	4,909,037
Reserve Position at IMF	12,500	13,571	24,120	—	—	—	—	13,558
Special Drawing Rights	17,627	28,323	31,492	1,652	3,923	7,827	11,882	14,505
Total Official Reserves	568,087	739,745	1,094,407	1,055,650	1,550,180	2,960,635	4,306,365	4,937,100
Exchange Rate of Won to U.S. Dollar	370.8	398.9	397.5	484.0	484.0	484.0	484.0	484.0

(1) Calculated at \$35 per troy ounce (31.1035 grams) until April 1972, at \$38 per troy ounce from May 1972, and at \$42.22 from October 1973.

Source: The Bank of Korea, Monthly Economic Statistics, Vol. XXXIII No. 7.

#### C.5.4 DEBT PROFILE AND DEBT SERVICE RATIO

The Republic's planners have, over time, implemented an economic plan, the results of which are reflected in the history of the Republic's debt service. Export-oriented business industries providing opportunities for import substitution (as well as conscious control of imports) have reduced Korea's debt-service ratio from respective levels of 21.0 percent and 20.1 percent in 1970 and 1971 to 12.8 percent in 1975. In its fourth five-year economic plan (1977-1981), the Republic's Economic Planning Board projects that the debt-service ratio will average 12.7 percent.

In addition to the statistical performance outlined above, the Republic has promptly and fully paid all debt service on all public external debt which it has issued since its foundation.

#### C.5.5 THE KOREAN BANKING SYSTEM

The Korean banking system itself is a key tool in implementing economic policy. Through the class A foreign exchange banks (the only Korean banks authorized to hold foreign currency accounts abroad) the Government administers import and export approvals as well as approvals of FX loans and guarantees.

Historically, the Korean banking system grew out of the banking organization created during the Japanese occupation of 1910-1945. Many of the characteristics of that system remain today.

Korea's central bank, the Bank of Korea, was established on June 12, 1950, after severe economic dislocations caused by runaway inflation mandated revision of the monetary system. The new statutes which revised the central banking laws were drafted by members of the U.S. Federal Reserve Bank of New York. Therefore, Korea's banking system structurally parallels that of the United States.

The Bank of Korea's monetary and credit policies are determined by a nine member Monetary Board which includes the Minister of Finance, Governor of the Bank of Korea (who is appointed by the President of the Republic for a four-year term), and seven other members (with terms of three years) who are also appointed by the President. This Board has the power to conduct open market operations as well as fix rediscount rates, reserve requirements, authorize the opening, merger, or liquidation of banking institutions, and conduct audits of banks. Korea's foreign exchange reserve are also managed by the Bank of Korea.

On July 28, 1966, the Republic passed the Korea Foreign Exchange Bank Act which established the Korea Exchange Bank in order to consolidate and ensure the smooth operation of foreign exchange transactions and finance. With the large expansion in the volume of Korea's trade and foreign currency requirements, the concentration of foreign exchange business gradually spreads to the Korea Development Bank and the Korean "City" banks.

**Table C.5-6**  
**DEBT PROFILE AND DEBT SERVICE RATIO**  
(In millions of U.S. dollars at current prices)

Item	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
A. Long-Term Debt Outstanding <sup>(1)</sup>	\$2,881	\$3,317	\$4,350	\$4,749	\$6,025	\$7,360	\$8,848	\$10,365	\$11,855	\$13,115
B. Current Receipts <sup>(2)</sup>	\$2,226	\$4,120	\$5,353	\$5,884	\$8,920	\$11,550	\$14,386	\$17,496	\$20,954	\$24,722
Outstanding Receipts Ratio (A/B)	-129.4%	80.5%	81.3%	80.7%	67.5%	63.7%	61.5%	59.2%	56.6%	53.0%
Long-Term Debt Service <sup>(1)</sup> :										
Principal	\$ 272	\$ 412	\$ 429	\$ 406	\$ 523	\$ 784	\$ 973	\$ 1,173	\$ 1,344	\$ 1,445
Interest	126	170	237	342	446	569	712	863	1,017	1,148
C. Total Long-Term Debt Service	\$ 398	\$ 582	\$ 666	\$ 748	\$ 969	\$ 1,353	\$ 1,685	\$ 2,036	\$ 2,361	\$ 2,593
Debt Service Ratio (C/B)	17.9%	14.1%	12.4%	12.7%	10.9%	11.7%	11.7%	11.6%	11.3%	10.5%

(1) One year or more.

(2) Commodity Exports plus Service Exports.

Source: Major Economic Indicators of The Fourth Five-Year Economic Development Plan (1977-1981), 1976, Economic Planning Board.

The following table shows the comparative assets of the banking system in the Republic.

**Table C.5-7**  
**KOREAN BANKING SYSTEM ASSETS<sup>(1)</sup>**  
(In billions of won)

Bank/Co-op	December 31,				
	1974	1975	1976	1977	1978
Korean Exchange Bank	1,600	1,927	2,213	3,219	4,592
Korea Development Bank	1,923	2,328	3,636	4,728	5,928
City Banks	2,798	4,112	5,770	7,777	11,121
Local Banks	393	661	877	1,150	1,524
Foreign Banks	120	260	359	628	932
Medium Industry Bank	225	288	351	484	738
Citizens National Bank	222	266	374	594	871
Korea Housing Bank	130	168	235	401	624
Agricultural Co-ops	474	646	815	1,126	1,591
Fisheries Co-ops	51	61	91	129	170
<b>Total</b>	<u>7,936</u>	<u>10,717</u>	<u>14,721</u>	<u>20,236</u>	<u>28,141</u>
Percentage Increase	—	34.9%	37.4%	37.5%	39.1%

(1) Excluding trust accounts, assets of overseas branches and subsidiaries and the Bank of Korea.

Source: The Bank of Korea, Monthly Economic Statistics, Vol. XXXIII No. 7.

### C.5.6 PRICE, WAGES AND EMPLOYMENT

The skilled Korean work force has been Korea's primary resource for economic development. Government policies have recognized this fact and given maximum effort to developing the technical skills of the work force through vocational and technical training in secondary schools and colleges as well as through training received in the military. As the following table indicates, the Government has endeavored to direct the economy so that the working force benefited from its effort.

Since early 1975, the Government has taken measures to retard price increases. However, the cost push factors from external commodity prices have somewhat hampered the Government's efforts. In 1975, wholesale prices rose by 26.5 percent and consumers' prices by 25.3 percent.

Table C.5-8  
PRICES, WAGES, AND EMPLOYMENT

Year	Wholesale Price Index 1970=100	Percent Increase over Previous Year	Consumer Price Index 1970=100	Percent Increase over Previous Year	Wage Index	Percent Increase over Previous Year	Unemployment as Percent of Economically Active Population
1970	100.0	n.a.	100.0	n.a.	100.0	n.a.	4.5
1971	108.6	8.6	119.2	19.2	119.9	19.9	4.5
1972	123.8	14.0	126.8	11.7	137.6	15.4	4.5
1973	132.4	6.9	130.8	3.2	150.8	9.6	4.0
1974	188.2	42.1	162.6	24.3	204.5	35.6	4.1
1975	238.0	26.5	203.7	25.3	259.3	26.8	4.1
1976	264.6	11.2	233.0	14.4	345.5	33.2	3.9
1977	290.8	9.9	258.7	11.0	460.3	33.2	3.8
1978	324.9	11.7	295.9	14.4	616.5	33.9	-

Source: The Bank of Korea, Monthly Economic Statistics, Vol. XXX No. 10 and Vol. XXXIII No. 7.



Wholesale prices have become more stable in 1977 rising at an annual rate of only 9.9 percent and consumer prices at an annual rate of 11.0 percent.

#### **C.5.7 GEOGRAPHY OF EXPORTS AND IMPORTS**

At the same time as the Republic's economic planners were implementing an expansion of exports, they directed geographic diversification of exports in an effort to increase volume as well as to reduce dependence on any one economy. As seen below, trade expansion with the Middle East and Europe has reduced export dependence on the U.S. and Japanese economies.

#### **C.5.8 PUBLIC DEBT**

The Republic's deficit has increased substantially but manageably since 1973 as a result of the Government's effort to become militarily self sufficient by 1981. Were it not for defense spending, the budgets would be in substantial surplus.

The money supply has expanded rapidly over the past several years with an average annual expansion rate of 32.7 percent between 1972 and 1978. The Government is currently implementing action to reduce this growth rate.

Table C.5-9  
GEOGRAPHY OF EXPORTS AND IMPORTS

County	EXPORTS				IMPORTS			
	(In thousands of U.S. Dollars)		Percent		(In thousands of U.S. Dollars)		Percent	
	1970	1978	1970	1978	1970	1978	1970	1978
Australia	2,905	148,828	.35	1.17	13,740	463,765	.69	3.10
Belgium	1,804	94,443	.22	0.74	12,369	88,736	.62	0.59
Canada	19,553	327,173	2.34	2.57	23,165	204,033	1.17	1.36
China, Republic of	7,210	140,079	.86	1.10	33,998	152,619	1.71	1.02
France	1,568	208,598	.19	1.64	52,242	442,377	2.63	2.95
Germany, F.R.	27,330	662,884	3.27	5.22	67,204	490,905	3.39	3.28
Ghana	1,925	9,846	.23	0.08	—	—	—	—
Hong Kong	27,574	384,686	3.30	3.03	19,738	50,601	.99	0.34
India	—	—	—	—	6,075	39,339	.31	0.26
Indonesia	2,704	102,982	.32	0.81	19,825	407,828	1.00	2.72
Iran	5,143	164,482	.62	1.28	39,489	169,468	1.99	1.13
Italy	7,182	117,840	.86	0.93	19,581	78,073	.99	0.52
Japan	234,329	2,627,266	28.06	20.87	809,283	5,981,487	40.79	39.95
Kuwait	1,515	240,638	.18	1.88	30,677	746,533	1.55	4.99
Malaysia	—	—	—	—	57,790	227,913	2.91	1.52
Netherlands	13,513	307,287	1.62	2.42	23,255	46,954	1.17	0.31
New Zealand	609	21,721	.07	0.17	3,196	80,553	.16	0.54
Nigeria	6,221	45,496	.74	0.36	—	—	—	—
Panama	2,395	91,215	.29	0.72	—	—	—	—
Philippines	—	—	—	—	41,683	48,173	2.10	0.32

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Table C.5-9 (Continued)  
GEOGRAPHY OF EXPORTS AND IMPORTS

County	EXPORTS				IMPORTS			
	(In thousands of U.S. Dollars)		Percent		(In thousands of U.S. Dollars)		Percent	
	1970	1978	1970	1978	1970	1978	1970	1978
Saudi Arabia	—	717,031	—	5.64	38,359	1,280,673	1.93	8.56
Singapore	11,023	143,630	1.32	1.13	13,543	61,225	.68	0.41
South Africa, Rep.	3,634	16,702	.44	0.13	3,891	27,381	.20	0.18
Sweden	7,885	157,652	.94	1.24	—	—	—	—
Switzerland	—	—	—	—	4,686	56,570	.24	0.38
Thailand	5,064	82,604	.61	0.65	—	84,906	—	0.57
United Kingdom	13,021	393,029	1.56	3.09	32,799	211,497	1.65	1.41
U.S.A.	395,182	4,058,345	47.32	31.93	584,793	3,042,950	29.48	20.33
Vietnam	12,759	—	1.52	—	—	—	—	—
Others	23,137	1,446,175	2.77	11.38	28,577	487,371	1.45	3.26
Total	<u>835,185</u>	<u>12,710,642</u>	<u>100%</u>	<u>100%</u>	<u>1,983,973</u>	<u>14,971,930</u>	<u>100%</u>	<u>100%</u>

Source: The Bank of Korea, Monthly Economic Statistics, Vol. XXX No. 10 & Vol. XXXIII No. 7.

**Table C.5-10**  
**PUBLIC DEBT**  
**FISCAL YEAR ENDING DECEMBER 31**

(In billions of won)

Item	1972	1973	1974	1975	1976	1977	1978 <sup>P</sup>
<b>Revenues</b>							
Direct Taxes	228.2	263.2	416.3	573.5	806.2	814.9	851.4
Indirect Taxes	146.2	175.9	301.7	438.8	564.3	860.3	1,401.4
Customs Duties	59.1	82.4	126.7	181.0	275.5	385.9	646.4
Defense Tax	—	—	—	62.2	268.7	341.6	473.3
Monopoly Profits	42.9	57.0	69.0	135.5	178.0	220.0	280.0
Contribution from Government Enterprise	61.3	63.6	109.7	148.8	207.4	221.1	275.5(P)
Others	<u>91.7</u>	<u>121.8</u>	<u>162.3</u>	<u>143.6</u>	<u>72.0</u>	<u>383.8</u>	<u>295.5(P)</u>
<b>Total Revenues</b>	<b>629.4</b>	<b>763.9</b>	<b>1,185.7</b>	<b>1,683.4</b>	<b>2,372.1</b>	<b>3,227.6</b>	<b>4,223.5(P)</b>
<b>Expenditures</b>							
Defense	173.9	183.5	296.8	451.7	711.9	958.8	1,239.4(P)
General Expenditures	266.9	276.3	401.9	543.4	729.7	1,417.7	1,837.7(P)
Fixed Capital Formation	120.5	121.3	172.9	283.5	365.2	463.0	635.8(P)
Others	<u>260.0</u>	<u>249.8</u>	<u>460.5</u>	<u>705.4</u>	<u>719.4</u>	<u>286.8</u>	<u>245.2(P)</u>
<b>Total Expenditure</b>	<b>821.3</b>	<b>830.9</b>	<b>1,332.1</b>	<b>1,984.0</b>	<b>2,526.2</b>	<b>3,126.3</b>	<b>3,958.1(P)</b>
Net Lending	<u>30.3</u>	<u>23.5</u>	<u>24.5</u>	<u>23.2</u>	<u>33.9</u>	<u>36.6</u>	<u>72.6(P)</u>
<b>Budget Deficit</b>	<b><u>222.2</u></b>	<b><u>90.5</u></b>	<b><u>170.9</u></b>	<b><u>323.8</u></b>	<b><u>188.0</u></b>	<b><u>(64.7)</u></b>	<b><u>(192.8)</u></b>

Source: The Bank of Korea, Monthly Economic Statistics, Vol. XXXIII No. 7.

Table C.5-11  
MONEY SUPPLY

(In billions of won)

Item	December 31						
	1972	1973	1974	1975	1976	1977	1978
Money Supply (M1)	519.4	730.3	945.7	1,181.7	1,544.0	2,172.6	2,713.8
Demand Deposits	301.7	418.9	535.2	674.5	867.2	1,219.2	1,349.4
Quasi Money	932.4	1,250.2	1,510.8	1,968.2	2,660.7	3,701.8	5,214.9
Money Supply (M2)	1,451.8	1,980.5	2,456.5	3,150.0	4,204.8	5,874.3	7,928.7
Percentage Increase	33.8%	36.4%	24.0%	28.2%	33.5%	39.7%	35.0%

Source: The Bank of Korea, Monthly Economic Statistics, Vol. XXXIII No.7

## APPENDIX D

### BENEFITS OF NUCLEAR POWER PLANT EXPORT KOREA NUCLEAR UNITS 7 AND 8

In support of KECO's application to the Eximbank in September 1979 for direct credits and guarantees to provide financing for the Korea Nuclear Units 7 and 8, an analysis was undertaken to measure the financial and employment impact that the proposed nuclear project will have on the United States.

#### D.1 Summary

The results of this analysis indicate that the U. S. exports associated with the project will have a significant impact on the U. S. balance of trade and the creation of employment over the planned seven year design and construction period. The benefits associated with the proposed nuclear units are summarized in Table D.1-1.

Table D.1-1

#### Summary Benefits of Nuclear Power Plant Export Korea Nuclear Units 7 & 8

Export Value (\$000)	\$1,101,000
Employment (man-years)	
Direct	24,800
Indirect	24,800
Total	49,600
Number of Subcontractors and Suppliers	1,200
Distribution of Benefits Throughout U. S.:	
Number of States	40
Number of Cities	250

This table indicates that:

- The proposed nuclear units are expected to generate \$1,101 million of U. S. exports, including materials and equipment, engineering and construction services, and nuclear fuel supply.
- These exports will result in the creation of an estimated 49,600 man-years of employment, consisting of 24,800 man-years of direct employment and approximately 24,800 man-years of indirect employment associated with a project of this type.
- About 1,200 suppliers and subcontractors for equipment and services will be involved, many of which are small business suppliers.

2x  
10x108  
5x104

- These benefits will be distributed throughout the U. S., particularly in 40 states and 250 cities. The nation-wide distribution of export value and employment is shown in Figure D.1-1.

## D.2 Evaluation

The evaluation was undertaken to measure the financial and employment impact of the export of U. S. goods and services to the proposed nuclear units. In preparing this evaluation, Bechtel, on behalf of KECO, reviewed and analyzed project data collected through its engineering/construction activities for nuclear power projects located outside the United States, and secured data from Westinghouse relating to the employment impact of U. S. contracts for supply of the NSSS and T/G equipment for the plant. The parameters reviewed and analyzed included:

- The dollar value of U. S. exports to these projects and the distribution of these exports by state, and in some cases cities, of origin.
- The number of jobs created by the U. S. exports. The employment impact was measured in terms of man-years of direct labor employed in supplying goods and services to the projects.
- The number and distribution of suppliers and subcontractors that contribute to the goods and services exported to the projects.

The results of the evaluation show that the Korea Nuclear 7 and 8 Power Plants would produce exports of \$1,101,000,000 and provide an estimated 24,800 man-years of direct employment through the seven year design and construction period. Moreover, the total employment impact extends beyond the direct labor related to the contractors and suppliers to the project. In addition to the direct man-years of employment, it is estimated that approximately 24,800 man-years of indirect labor would be created in local U. S. service and support sectors, such as financial and transportation services, and many other local community and business establishments, usually located in the vicinity of the suppliers.\*

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\* This one-to-one relationship between direct and indirect labor was based on a study prepared by Brookhaven National Lab, entitled Regional Economic Impacts of Nuclear Power Plants, 1976.

**FIGURE D.1-1**  
**DISTRIBUTION OF EXPORT VALUE AND EMPLOYMENT**

\$: Millions of Dollars Export  
M: Man-Years of Direct Employment

**TOTAL U.S.:** \$1,101  
M24,800

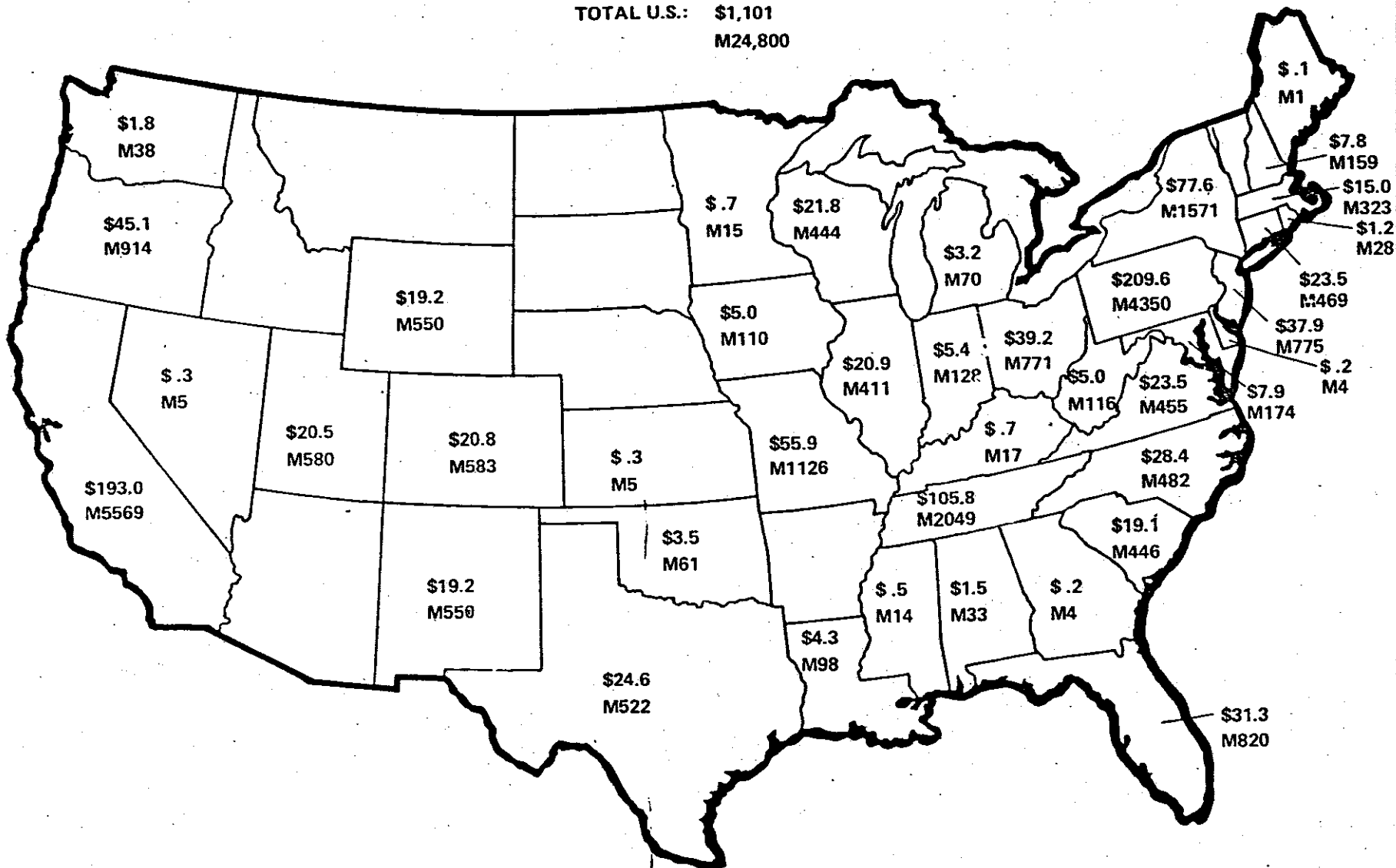




Table D.2-1 describes the type of benefits in export dollars, as described in the Eximbank Loan Application, and the man-years associated with selected categories of equipment and service exports.

Table D.2-1

Benefits of a Nuclear Power Plant Export  
Two 950 MWe Plants

	<u>Export Value</u> (\$ Thousand)	<u>Employment</u> Man-Years
<b>DIRECT LABOR</b>		
NSSS Equipment and Services	\$	
T/G Equipment and Services		
Balance of Plant Equipment, Materials, and Services*	673,300	15,200
Nuclear Fuel Services	<u>182,900</u>	<u>3,900</u>
<b>TOTAL</b>	<b>\$1,101,500</b>	<b>24,800</b>
<b>INDIRECT LABOR</b>		<u>24,800</u>
<b>TOTAL LABOR</b>		<u>49,600</u>

\* Export value of Balance of Plant Equipment, Material, and Services includes Owner's Contingency of \$108.1 million to cover cost escalation and other uncertainties; no man-years of employment have been added for this contingency.

Nuclear power plant exports are a vital part of the growth of the nuclear industry and other related businesses. Although certain major contracts for this project are let to large U. S. corporations, there are thousands of suppliers and subcontractors which are heavily relied upon. This is illustrated by the 1,200 subcontracts for equipment and services expected to be let to companies in 40 states.

The state-by-state summary of the dollar value of the exports, direct man-years of employment, and the number of suppliers and subcontractors affected by the Korean nuclear units is presented in Table D.2-2. The number of cities affected within each state is also estimated. This table shows the widespread contribution of the proposed project to U. S. trade and payment balances, employment, and continued economic growth.

Table D.2-2  
**FINANCIAL AND EMPLOYMENT EFFECT OF NUCLEAR POWER EXPORTS  
 KOREA NUCLEAR UNITS 7 AND 8**

<u>State</u>	<u>Cities</u>	<u>Value of Exports</u> (\$000)	<u>Employment</u> <u>Man-Years</u>	<u>Suppliers and</u> <u>Subcontractors</u>
Alabama	4	1508	33	7
California	12	193021	5569	465
Colorado	5	20814	583	19
Connecticut	12	23513	469	30
Delaware	1	170	4	1
Florida	2	31291	820	9
Georgia	2	169	4	3
Illinois	17	20891	411	44
Indiana	9	5436	128	13
Iowa	2	5046	110	6
Kansas	1	333	5	1
Kentucky	2	725	17	7
Louisiana	3	4253	98	3
Maine	1	55	1	2
Maryland	4	7957	174	10
Massachusetts	9	14957	323	27
Michigan	9	3222	70	20
Minnesota	2	728	15	2
Mississippi	1	530	14	1
Missouri	3	55860	1126	10
Nevada	1	258	5	3
New Hampshire	1	7844	159	2
New Jersey	13	37865	775	44
New Mexico	5	19203	550	17
New York	15	77576	1571	53
North Carolina	4	28417	482	9
Ohio	15	39245	771	59
Oklahoma	1	3455	61	5
Oregon	3	45134	914	10
Pennsylvania	49	209559	4350	163
Rhode Island	2	1192	28	2
South Carolina	2	19130	446	4
Tennessee	5	105762	2049	45
Texas	7	24580	522	29
Utah	5	20540	580	19
Virginia	4	23475	455	13
Washington	4	1787	38	9
West Virginia	4	5027	116	3
Wisconsin	5	21772	444	12
Wyoming	5	19200	550	16
<b>TOTAL</b>	<b>251</b>	<b>1101500</b>	<b>24840</b>	<b>1197</b>
<b>Rounded Total</b>	<b>250</b>	<b>1101000</b>	<b>24800</b>	<b>1200</b>

### D.3 Additional Benefits of Nuclear Exports

The level of exports and job creation associated with the Korean Nuclear Units 7 and 8 extends beyond those quantified above and does not stop when the plant is completed and operating in 1987. Other benefits related to exports to this project include the following:

- Additional employment could result from the sale of the reload fuel for continuing operation of the power plants and the supply of certain spare parts and services. Sales for fuel cycle services, uranium, enrichment and fuel fabrication alone could result in over \$100 million exports per year and 1,300 additional jobs.
- U. S. industry will continue to be placed in a prime position to provide similar services and exports to other nuclear, as well as fossil, power plants to Korea. As noted in the loan application to Eximbank, Korea's dramatic economic growth is to be supported by a long range power development program which will provide opportunities for U. S. exports in the future. Indeed, KECO has announced plans to purchase additional nuclear units during the next year or two. Eximbank financing assistance places U. S. industry, as a whole, in a favorable position to provide future exports of goods and services to all sectors of the Korean economy.
- Tax revenues will be generated by the sale of goods and services and by income generated at the federal, state and local levels.
- The proposed nuclear export will help reduce the cost of domestic nuclear power plants by spreading the overall cost of U. S. nuclear manufacturing facilities over more units and by enabling the nuclear industry to achieve a levelized workload and maintain a skilled work force. Further, cash flow from such exports will enable the nuclear industry to continue its high level of R&D activities.
- A final benefit which is intangible, but none the less important, is the political and national security implications of contributing to a strong and healthy Korean economy.

### D.4 Conclusion

The support of Eximbank financing assistance for the proposed Korean nuclear power project is critically important to the United States in terms of the generation of exports, the creation of jobs, and other related benefits. Without appropriate Eximbank assistance, these nuclear units will be supplied by eager foreign competitors supported by favorable financing, and the exports and jobs outlined in this memorandum would surely be lost.

Word for word of Exim's of Section 101.101. PR for KECO & Exim (nice of them)

(see if in (2) (2000)) \*

Cuts?