united engineers & constructors inc.
30 South 17th Street
Post Office Box 8223
Philadelphia, PA 19101

BOSTON
ECHELON
KNOXVILLE
PHILADELPHIA

December 26, 1979

Mr. Mervin W. Koehlinger
Plans and Analysis Division
Office of Nuclear Energy Programs
Mailing Station B-107
U.S. Department of Energy
Washington, DC 20545

Dear Mr. Koehlinger:

Subject: U.S. Department of Energy
Energy Economic Data Base (EEDB) Program-Phase I
Contract No. EN-78-C-02-4954

We are transmitting herewith twenty-five (25) copies of "Final Report and Initial Update of the Energy Economic Data Base (EEDB) Program-Phase I," dated December 1979.

This document is the final report for work done under Phase I of the subject contract and consists of three (3) volumes. The report discusses the establishment of the Energy Economic Data Base and presents the results of the Initial Update of the data base for the effective cost and regulation date of January 1, 1978. Section 4 of Volume I, in general, and Tables 4-1, 4-2 and 4-4, in particular, summarize the technical features and the capital, fuel cycle and operating and maintenance costs of the 12 nuclear and alternative power generating stations in the data base.

This final report contains all of the deliverables required under the subject contract with the exception of the Executive Summary Report and the CONCICE cost and commodity computer printouts. The Executive Summary Report was included in "Interim Report for the Energy Economic Data Base Project - 12/19/78" and was delivered to USDOE at a meeting in Germantown, MD on December 19, 1978. CONCICE/PEGASUS cost/equipment and commodity computer printouts are bound separately. One (1) copy of each of 36 volumes of printouts are being forwarded under separate cover because of their bulk.

Very truly yours,

R. E. Allen
EEDB Program Project Manager

REA/avs
Enclosures

cc w/enc.: S. T. Brewer, DOE-ETN
J. D. Greenwood, DOE COO (2)
E. V. Gallagher, DOE COO

REA

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FINAL REPORT

AND

INITIAL UPDATE

OF THE

ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM PHASE I

PREPARED FOR

THE U.S. DEPARTMENT OF ENERGY
UNDER CONTRACT NUMBER EN—78-C-02-4954

VOLUME I OF III

BY

united engineers
& constructors inc.

DECEMBER 1979

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FINAL REPORT AND INITIAL UPDATE OF THE ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM PHASE I

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LIST OF PRINCIPAL CONTRIBUTORS

J. H. Crowley, Manager
Advanced Engineering Department

*R. E. Allen, Program Project Manager
Energy Economic Data Base Program

R. G. Benedict

H. L. Bermanis

* P. E. Brown

R. A. Brusato

J. A. Daniel

G. F. Frey

A. L. Garrett

P. M. Karousakis

N. H. Lee

J. K. Lin

G. G. McComb

A. T. Molin

J. B. Newman

U. K. Rath

* M. H. Smith

* E. J. Ziegler

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* Principal Authors

TABLE LIST

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FIGURE LIST

1.0 INTRODUCTION

1.1 AUTHORIZATION

The Energy Economic Data Base (EEDB) Program, which deals with the development of cost data for nuclear and comparison electric power generating stations, is authorized by the U.S. Department of Energy (DOE), and funded under their Contract No. EN-78-C-02-4954 with United Engineers & Constructors Inc. (UE&C).

1.2 OBJECTIVE

The objective of the EEDB Program is to provide periodic updates of technical and cost (capital, fuel and operating and maintenance) information of significance to the Department of Energy (Office of Nuclear Energy Programs - Plans and Analysis Division). This information is intended to be used by DOE in evaluating and monitoring U.S. civilian nuclear power programs, and to provide them with a consistent means of evaluating the nuclear option against alternatives.

1.3 BASIS OF STUDY

In the achievement of the objective of this study, it is necessary to perform a number of basic tasks:

a. Develop an overall plan for the establishment, operation and maintenance of the EEDB Program.

b. Establish base technical and capital cost data models for nuclear power generating station energy sources identified in Table 1-1.

c. Establish base technical and capital cost data models for comparison power generating station energy sources identified in Table 1-2, for comparison with the nuclear option.

d. Define and establish base fuel cycle (mine to disposal) costs for coal, uranium and thorium. Detailed cost models, as applicable, may be evolved as future work develops.

e. Define and establish base operating and maintenance costs for nuclear and fossil fueled plants. Detailed cost models, as applicable, may be evolved as future work develops.

f. Determine sources which must be followed to identify technical or cost perturbations, and establish the procedure by which this information is tracked and integrated into the periodic updating of the EEDB.

g. Identify efforts required to expand the data base of the EEDB Program from that developed in Tasks (a) through (f) above, to provide a more comprehensive cost data reporting system.

h. Initiate an ongoing effort to track the sources identified in Task (f).

i. Initiate an effort to publish the first periodic update of technical and cost (capital, fuel and operating and maintenance) information, based upon the results obtained from Tasks (a) through (f) and (h).

1.4 DATA BASE COMPONENTS

Currently, the EEDB contains six nuclear electrical generating plant technical models and five comparison coal-fired electrical generating plant technical models. Each of these technical plant models is a complete conceptual design for a single unit, steam electric power generating station located on a standard, hypothetical "Middletown" site. A description of the "Middletown" site is provided in Appendix A-1 for nuclear plants, and Appendix A-2 for coal-fired plants. In addition, the EEDB also includes a conceptual design of a coal liquefaction plant for comparison purposes. Tables 1-1 and 1-2 list respectively the six nuclear and five comparison electrical power generating stations, and the coal liquefaction plant, and their associated capacities.

Technical models and capital costs for these plants are based on an evaluation of related capital cost studies prepared for the Department of Energy and its predecessor agencies, the Energy Research and Development Administration (ERDA) and the Atomic Energy Commission (AEC), and for the Nuclear Regulatory Commission (NRC) and its predecessor agency, the Atomic Energy Commission, over the last 12 years. In addition, other studies prepared for various government agencies and other organizations also contribute to the development of the capital, fuel, and operating and maintenance (O&M) cost data presented in this report.

The base studies and reports from which this initial update has evolved for the technical and capital, fuel and O&M cost data, are tabulated in Tables 1-3, 1-4 and 1-5.

Section 2 of this report provides a description of the current Data Base, as of September 30, 1978. In Section 3, assumptions and groundrules for the initial cost update are identified. Section 4 summarizes the initial cost update, with cost results tabulated in Tables 4-4, 4-5 and 4-6. Section 5 comprises the details of the initial update of the technical conceptual design, the capital cost, the quantities of commodities and their unit costs, and craft labor manhours and costs for each EEDB program model. Sections 6 and 7 describe the details of the fuel cycle cost initial update and the operating and maintenance cost initial update respectively. Section 8 contains a glossary of acronyms and mnemonics used in this report and a complete list of references.

TABLE 1-1

ENERGY ECONOMIC DATA BASE

INITIAL UPDATE
NUCLEAR POWER GENERATING STATIONS

EEDB Model Number	Plant Type	Net Capacity
A1	Boiling Water Reactor Plant (BWR)	1190 MWe
A2	High Temperature Gas Cooled Reactor Plant (HTGR)	1330 MWe
A3	Pressurized Water Reactor Plant (PWR)	1139 MWe
A4	Pressurized Heavy Water Reactor Plant (PHWR)	1162 MWe
B1	Gas Cooled Fast Reactor Plant (GCFR)	917 MWe
B2	Liquid Metal Fast Breeder Reactor Plant (LMFBR)	1390 MWe

TABLE 1-2

ENERGY ECONOMIC DATA BASE

INITIAL UPDATE
COMPARISON POWER GENERATING STATIONS*

EEDB Model Number	Plant Type		Net Capacity
C1	Comparison High Sulfur Coal Plant	(HS12)	1232 MWe
C2	Comparison High Sulfur Coal Plant	(HS8)	795 MWe
C3	Comparison Low Sulfur Coal Plant	(LS12)	1243 MWe
C4	Comparison Low Sulfur Coal Plant	(LS8)	802 MWe
D1	Comparison Coal Gasification Combined Cycle Plant	(CGCC)	630 MWe
D2	Coal Liquefaction Conversion Plant	(CLIQ)	86,800 bbl/d Oil 36×10^6 SCFD Natural Gas

* Model Number D2 does not produce net electric power.

TABLE 1-3

ENERGY ECONOMIC DATA BASE

TECHNICAL AND CAPITAL COST MODELS BASE DATA STUDIES AND REPORTS

EEDB Model Number	Model Type	Base Data Study or Report
A1	BWR	Commercial, Electric Power Cost Studies - Capital Cost - Boiling Water Reactor Plant (NUREG-0242, COO-2477-6)
A2	HTGR	3360 MWt HTGR - Steam Cycle Reference Plant Design (General Atomic Company-SC 558623)
A3	PWR	Commercial Electric Power Cost Studies - Capital Cost - Pressurized Water Reactor Plant (NUREG-0241, COO-2477-5)
A4	PHWR	Commercial Electric Power Cost Studies - Capital Cost - Pressurized Heavy Water Reactor Plant (COO-2477-13)
B1	GCFR	Capital Cost - Gas Cooled Fast Reactor Plant (COO-2477-16)
B2	LMFBR	Technical Comparison of Prototype Large Breeder Reactor (PLBR) Phase II Competing Designs (31-109-38-3547)
C1	HS12	Commercial Electric Power Cost Studies - Capital Cost - High and Low Sulfur Coal Plants - 1200 MWe (Nominal) (NUREG-0243, COO-2477-7)
C2	HS8	Commercial Electric Power Cost Studies - Capital Cost - Low and High Sulfur Coal Plants - 800 MWe (Nominal) (NUREG-0244, COO-2477-8)
C3	LS12	Same as EEDB Model C1
C4	LS8	Same as EEDB Model C2
D1	CGCC	Study of Electric Plant Applications for Low Btu Gasification of Coal for Electric Power Generation (FE-1545-59)
D2	CLIQ	Recycle Solvent Refined Coal (SRC) Processing for Liquid and Solid Fuels, Gulf Mineral Resources Company

TABLE 1-4

ENERGY ECONOMIC DATA BASE
FUEL CYCLE COST MODELS
BASE DATA STUDIES AND REPORTS

EEDB Model Number	Model Type	Base Data Study or Report
A1	BWR	Advance Information from Unpublished (as of the effective date of this report) Documents as follows: a. NUREG-0246, "Commercial Electric Power Cost Studies - Fuel Supply Investment Cost: Coal and Nuclear" b. NUREG-0248, "Commercial Electric Power Cost Studies - Total Generating Costs: Coal and Nuclear Plants"
A2	HTGR	
A3	PWR	
A4	PHWR	
B1	GCFR	
B2	LMFBR	
C1	HS12	
C2	HS8	
C3	LS12	
C4	LS8	
D1	CGCC	Study of Electric Plant Applications for Low Btu Gasification of Coal for Electric Power Generation (FE-1545-59)
D2	CLIQ	Recycle Solvent Refined Coal (SRC) Processing for Liquid and Solid Fuels, Gulf Mineral Resources Company

TABLE 1-5

ENERGY ECONOMIC DATA BASE

OPERATING AND MAINTENANCE COST MODELS
BASE DATA STUDIES AND REPORTS

EEDB Model Number	Model Type	Base Data Study or Report
A1	BWR	A Procedure for Estimating Nonfuel Operating and Maintenance Costs for Large Steam-Electric Power Plants; ERDA 76-37; October, 1975
A2	HTGR	Advance Information from Unpublished (as of the effective date of this report) Report Guidelines for Estimating Nonfuel Operating and Maintenance Costs for Alternative Nuclear Plants
A3	PWR	Same as Model A1
A4	PHWR	Same as Model A2
B1	GCFR	Same as Model A2
B2	LMFBR	Same as Model A2
C1	HS12	Same as Model A1
C2	HS8	Same as Model A1
C3	LS12	Same as Model A1
C4	LS8	Same as Model A1
D1	CGCC	Same as Model A1
D2	CLIQ	Not Applicable

SECTION 2

2.0 DESCRIPTION OF THE ENERGY ECONOMIC DATA BASE

The Energy Economic Data Base (EEDB) is the collection of previously developed Base Data Studies and Reports that are listed in Tables 1-3, 1-4 and 1-5. These studies and reports reflect cost and design data earlier than January 1, 1978. The Initial Update of the EEDB is the uniform and consistent revision of these Base Data Studies and Reports to reflect a cost and regulation date of January 1, 1978, current design practice and a common set of groundrules and assumptions. The Initial Update was accomplished during Fiscal Year 1978, ending September 30, 1978.

The term "Base Data Studies and Reports," as used in this report, refers to the previously developed data tabulated in Tables 1-3, 1-4 and 1-5.

The term "Initial Update" refers to the uniform and consistent revision of the Base Data Studies and Reports performed during Phase I of the Energy Economic Data Base Program (EEDB-I) for Fiscal Year 1978.

2.1 SELECTION OF MODELS FOR THE DATA BASE

Selection of power generating station types and associated fuel cycles to be included in the EEDB is based on the DOE objectives and the availability of existing cost information discussed in Section 1.

Nuclear power generating station types are selected to provide a cross section of current and developing technology experience in the United States.

Cross Section of Nuclear Technology Experience (See Table 1-1)

Current Technology	Developing Technology	
Light Water Reactors	Converters	Breeders
PWR	HTGR	LMFBR
BWR	PHWR	GCFR

Comparison plant types are selected to provide alternatives for comparison with the nuclear plant types. Current technology experience is represented by coal-fired power generating stations of appropriate size, including plants which burn either high sulfur or low sulfur coals. A coal gasification combined cycle plant and a coal liquefaction plant are included to provide a basis for comparison to developing technologies.

Cross Section of Comparison Technology Experience (See Table 1-2)

Current Technology		Developing Technology
High Sulfur Coal	Low Sulfur Coal	
800 MWe	800 MWe	Coal Gasification Combined Cycle
1200 MWe	1200 MWe	Coal Liquefaction

2.2 COMPOSITION OF THE DATA BASE

The data base is composed of the following five elements for each of the power generating stations listed in Tables 1-1 and 1-2:

a. A Technical (Conceptual Design) Model

b. A Capital Cost Model

c. A Fuel Cycle Cost Model

d. An Operating and Maintenance Cost Model

e. A Back-up Data File

2.2.1 Technical Models

The Technical Models are detailed conceptual descriptions of the plants in the data base, and appear in the documents referenced in Table 1-3. They are the key to the level of detail found in the capital cost models and, consequently, to the degree of accuracy for the comparative results reported in the data base.

Each Technical Model is composed of:

a. Heat Cycle Diagram
b. Major System Flow Diagrams
c. Electrical One Line Diagram
d. Plot Plan
e. Major Building and Equipment Arrangement Drawings
f. Detailed Equipment List

Revision of the detailed equipment lists is the means for updating the technical models in the data base. The diagrams, plans and drawings in the base data studies and reports serve as resources for support of the equipment list revisions.

2.2.1.1 Equipment Lists

The detailed equipment lists are developed from PEGASUS (Power Plant Economic Generator and Scale-Up System), a proprietary computer program of United Engineers & Constructors Inc. of Philadelphia, PA. PEGASUS utilizes an expanded Code-of-Accounts derived from "Guide for Economic Evaluation of Nuclear Reactor Plant Designs," USAEC Report NUS-531 (1969), developed for the U.S. Atomic Energy Commission (now Department of Energy and Nuclear Regulatory Commission) by NUS Corporation of Rockville, MD.

The PEGASUS program tabulates engineering data, which describes the equipment and material used in the plant design and their quantities. This is accomplished through use of a mini-specification of standardized format developed for each account in the equipment listing. Mini-specifications are not used for materials (e.g., concrete) listings. Samples of two mini-specifications, one for a circulating water pump and its motor and one for medium voltage electrical switchgear, are provided in Tables 2-1 and 2-2.

Additionally, the PEGASUS program contains unit cost data for material and equipment and associated labor data, such as craft manhours, composite craft mixes and craft labor rates. PEGASUS also has the capability of developing technical models for various capacity plants by scaling a known plant capacity model in accordance with the procedure described in Section 4.

PEGASUS, as the basic Technical Model in the Data Base, directly supports the Capital Cost Models as discussed in Section 2.2.2.

2.2.1.2 Maturity of Technical Models

The structure of the expanded Code-of-Accounts used in the Equipment List permits the degree of detail entered in the model to vary according to the amount of information that is available. Consequently, mature models, where considerable information is available, are detailed to the "nine-digit" level, whereas less mature models are detailed to the "three-digit" or summary level. Table 2-3 shows the significance of the various levels of detail, as related to the information provided. Nuclear power generating station models detailed to the "nine-digit" level, contain approximately 10,000 lines of information, while comparison power generating station models detailed to the same level, contain approximately 5,000 lines of information. The difference is primarily due to the greater complexity and redundancy of systems in the nuclear power generating station models.

The current (initial) update of the EEDB contains technical models of varying degrees of detail. In Tables 1-1 and 1-2, the "A" and "C" models are detailed to the "seven-digit" to "nine-digit" levels, and the "B" and "D" models to the "three-digit" level.

2.2.2 Capital Cost Models

The Capital Cost Models for the plants in the data base are developed from CONCICE (CONceptual Construction Investment Cost Estimate), a proprietary computer program of United Engineers & Constructors Inc. of Philadelphia, PA. The CONCICE program utilizes extensive technical and unit cost data from PEGASUS, by means of an interface program, to develop capital cost models. Consequently, the more detailed the Technical Model in PEGASUS, the more detailed the capital cost model developed by CONCICE can be. CONCICE is similar to and compatible with the Department of Energy CONCEPT code. It contains information for each account in the Technical Model in terms of factory equipment, site labor and site material costs. CONCICE categorizes these accounts into direct and indirect capital costs, and sums them into a total base cost. Table 2-4 illustrates a typical CONCICE capital cost model for a Boiling Water Reactor Plant at the "two-digit" level. When required, the CONCICE computer program can provide a number of economic analyses of the cost models in the data base, as follows:

a. Comparative Economics

b. Cost Projections

c. Cost Analysis

d. Cash Flow Analysis

e. Trend Analysis

f. Parametric Analysis

2.2.3 Fuel Cycle Cost Models

Two different fuel cycle cost models are utilized in the EEDB; the Nuclear Fuel Cycle Cost Model and the Coal Fuel Cycle Cost Model. The two models are structured differently, as follows:

a. The nuclear fuel cycle covers a complete reactor fuel cycle from mining of uranium ore through reprocessing of irradiated fuel recovery of uranium, plutonium or thorium from spent fuel and shipment of high level waste to permanent storage.

b. The coal fuel cycle includes only the mining of coal and transportation to its point of use. Storage and disposal of wastes are accounted for in the Coal Plant Operating & Maintenance Cost models.

2.2.3.1 Nuclear Fuels

The nuclear fuel cycle costs are based on the principles developed in, and reported in the Code-of-Accounts derived from, "Guide for Economic Evaluation of Nuclear Reactor Plant Designs," USAEC Report NUS-531 (1969), in general and Section 6 in particular.

NUS Corporation (NUS) of Rockville, Maryland, performed the nuclear fuel cycle cost analyses for the EEDB Program under subcontract to UE&C per NUS Proposal No. 7805025. A summary of the NUS reports contributing to the EEDB Program is given in Appendix B. The costing methodology and the calculations are developed from FUELCOST-V, a proprietary computer program of NUS, and reported in NUS-3081, January 1978.

The utility economics of using nuclear fuel for the generation of electricity is simulated by:

a. Providing Direct costs for materials, processes, and services as input.

b. Estimating Indirect costs by an "interest rate" approach which is derivable from a discount cash flow approach.

FUELCOST-V takes the input values for the direct costs, makes adjustments to reflect the time-value of money spent before and after utilization of the fuel in the reactor, and amortizes the net direct costs in proportion to the amount of energy generated over a fixed calendar time, e.g., one year. FUELCOST-V treats indirect costs like an interest cost on borrowed money. Such an interest rate may be considered as the composite cost of money, including such parameters as borrowing costs, rate of return on equity and taxes. The program calculates the indirect costs as equal to simple interest on the average balance over the time period of energy production at an interest rate equal to the discount rate.

The fuel cycle costs, both direct and indirect, are levelized over a 30-year period using an appropriate discount rate.

The input nuclear fuel cost components are given with appropriate account designations as unit costs by calendar years, shown typically in Table 2-5. The output nuclear fuel cost components are given with appropriate account designations in cost per energy unit by reactor operating year, together with the 30-year levelized total costs, shown typically in Table 2-6.

2.2.3.2 Coal

The costs of coal as fuel are based on a number of complicating factors which strongly affect the costs to the user. The preponderant coal cost factors are mine mouth costs and transportation costs.

The quality of coal, as regards both heating value and sulfur content, influences the cost of use, but is so dependent on site specific factors that generalizations are not attempted. Typical costs for high and low sulfur content coals shipped to the representative "Middletown" site are presented in Section 6, with the extraction and the transportation costs given explicitly. The reagent cost for desulfurization and the charges for disposal of waste, combining fly ash, bottom ash, and desulfurization products, are traditionally charged against operation and maintenance rather than attributed to the fuel cycle. In the EEDB, these costs are included in the appropriate Operating and Maintenance Cost Models.

2.2.4 Operating and Maintenance Cost Models

The Operating and Maintenance Cost Models in the EEDB are based on the Oak Ridge National Laboratory report ORNL/TM-6467, "A Procedure for Estimating Nonfuel Operation and Maintenance Costs for Large Steam-Electric Power Plants." The cost estimating procedure involves the application of empirical functions that represent historical cost experience plus new factors arising from regulatory and economic considerations.

Oak Ridge National Laboratory (ORNL) provided O&M data in the form of staffing and material requirements for each of the EEDB technical models. The O&M costs are generated by OMCOST, a digital computer program developed by ORNL, based on the procedures given in report ORNL/TM-6467.

Cost functions are those for hypothetical plants and are given in terms of 1978 dollars. Although the intent was not to reflect specific operating philosophy or experience, data from published and private sources were examined to insure that the reference plants were realistic. Factors considered in formulating guidelines were plant design, staff training, personnel motivation, outage planning, regulatory provisions, operating load, hours of service, and number of outages and startups.

Tables 2-7 and 2-8 are typical outputs from the OMCOST program with a standard set of accounts for nuclear and fossil power plants.

2.2.5 EEDB Back-up Data File

The Back-up Data File contains all of the information and documentation acquired or developed, including the documents listed in Tables 1-3 through 1-5, to produce the data contained in this report. All of the information described above is not included herein. In the interest of keeping this report to a manageable size, the following information is omitted from the report, but is included in the Back-up Data File:

a. Technical Data, including the detailed Equipment Lists, other than the Base Parameter Summaries.

b. Capital Cost Data below the three-digit level.

c. Inflated Operating and Maintenance Cost Data.

d. Resource Data, including all of the documents listed in Tables 1-3, 1-4 and 1-5.

Any of the information contained in the Back-up Data File may be obtained by contacting:

United Engineers & Constructors Inc.
30 South 17th Street
P.O. Box 8223
Philadelphia, PA 19101

Attention: R. E. Allen
EEDB Program Project Manager
(215) 422-3734

after receiving release for distribution of information from:

Mr. Mervin W. Koehlinger (301) 353-5448
Plans and Analysis Division
Office of Nuclear Energy Programs
Mailing Station B-107
U.S. Department of Energy
Washington, DC 20545

2.3 APPROACH TO PRESENTATION OF COST DATA

The capital, fuel and operating and maintenance costs developed and presented in this report are in constant January 1, 1978 dollars. The objective is to present comparable baseline costs in the three cost areas of interest that are unencumbered by controversial factors, such as the effects of future inflation, and non-uniform factors such as costs arising from owner options or utility system configuration. The user of this data may add whatever factors may be desired to the base costs, in order to make reliable comparisons based on unique requirements. Additionally, this approach promotes greater understanding and acceptance of disputed comparisons, because all components of "bottom-line" numbers are readily identified. Consequently, differences or similarities in compared alternatives may be identified as base costs, inflationary costs or preferential costs. Where comparisons are made of the capital costs of the various alternatives, unit costs, based on tabulated quantities of commodities, can be compared as credibility checks.

2.3.1 Items Not Included in Capital Cost Data

Preferential and utility system related cost components that are NOT included in the capital cost data presented in this report are tabulated in Table 2-9. Many of these non-uniform cost factors are dependent on the choice of the owner rather than on the intrinsic characteristics of the plant. These cost factors, especially those which are related to the time-value of money are significant fractions of the total costs involved. Because of the variability of these cost factors, they are deliberately excluded from the costs presented herein.

Information related to owner's costs appear in NUREG-0248, "Commercial Electric Power Cost Studies - Total Generating Costs: Coal and Nuclear Plants."

2.3.2 Escalation

As defined in this report, escalation (e) is comprised of two additive components; one based on rising inflation rates (e_i) and the other based on rising material scarcity (e_s).

The capital, fuel and operating and maintenance costs are developed on an inflation-free (constant dollar) basis for the EEDB. Therefore, the inflation rate is zero ($e_i = 0$) for these cost components. The scarcity of material is negligible for capital and operating and maintenance costs, but significant for the cost of coal and nuclear fuels. Therefore, escalation for scarcity is considered to be zero ($e_s = 0$) for capital and operating and maintenance costs, but greater than zero ($e_s > 0$) for coal and nuclear fuel costs. The fuel costs are discussed in greater detail in Section 6.

2.3.3 Total Generating Costs and Life Cycle Costs

The base capital, fuel cycle and operating and maintenance costs in this report cannot be summed directly to obtain Total Generating and Life Cycle Costs. A simple summation of the capital, fuel cycle, and Operating and Maintenance costs can only give cost data which are useful for comparison of the relative costs of alternatives. These totals are not intended to represent the Total Generating or Life Cycle Costs.

To prepare Total Generating and Life Cycle Costs from data in this report, the excluded items described in paragraph 2.3.1 and the effects of inflation discussed in paragraph 2.3.2, must be combined with the base costs presented herein, in accordance with consistent and documented groundrules and assumptions. Preparation of Total Generating Costs and Life Cycle Costs is beyond the scope of this report.

TABLE 2-1

ENERGY ECONOMIC DATA BASE
MINI-SPECIFICATION - CIRCULATING WATER PUMP
(Cost Basis 01/78)

PROG. CM-711 *PEG030*

EQUIPMENT LIST - REPORT 1

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MODEL 148 - 1139 MWE/3425 MWT PWR - 2.5 IN HG AV - MIDDLETOWN,USA - COST BASIS 01/78

ACCOUNT NUMBER	ITEM		DESCRIPTION
262.1211	CIRCULATING WATER PUMP+MTR		
262.12111	CIPC WATER PUMP	QUANTITY	4 X 25 PCT
		TYPE	MIXED FLOW
		ORIENTATION	VERTICAL
		FLOW RATE	147,500 GPM
		SPEED	320 RPM
		TDH	105 FT
		BHP	4,414 HP
		NPSH	30 FT
		EFFICIENCY	88.6 PCT
		DESIGN PRESS	150 PSIA
		DESIGN TEMP	100 F
		MATERIAL	NI-RESIST COL. AND BOWL S.S. IMPELLER
		SAFETY CLASS	NNS
		SEISMIC CAT.	NONE
		DESIGN CODE	
262.12112	CIRC WATER PUMP MOTOR	QUANTITY -	4 X 25 PCT
		TYPE -	AC INDUCTION
		HORSEPOWER	5,000 HP
		SPEED	320 RPM
		VOLTAGE	13.2 KV, 3 PHASE, 60 HZ

TABLE 2-2

ENERGY ECONOMIC DATA BASE

MINI-SPECIFICATION - CIRCULATING WATER PUMP SWITCHGEAR

(Cost Basis 01/78)

MODEL 148 - 1139 MWE/3425 MWT PWR - 2.5 IN HG AV - MIDDLETOWN,USA

ACCOUNT NUMBER	ITEM	DESCRIPTION
241.2131	NON-CLASS 1E 4.16 KV	TWO 4.16 KV BUSES CONSISTING OF INDOOR METAL CLAD SWITCHGEAR : NOMINAL VOLTAGE : 5 KV NOMINAL MVA CLASS : 350 MVA CONTINUOUS CURRENT - INCOMING LINE ACB : 1200 A FEEDER ACB : 1200 A BUS : 1200 A RATED SHORT CIRCUIT CURRENT: 41000 A, RMS@4.76 KV INTERRUPTING TIME : 5 CYCLES CLOSING AND LATCHING CAPABILITY : 78000 A, RMS QUANTITIES - INCOMING LINE : 4 FEEDER : 17 SPACE : 2 PT COMP'TS : 6 EACH BUS IS COMPLETE WITH METERING, PROTECTIVE RELAYING, AND CONTROL LOGIC

TABLE 2-3

ENERGY ECONOMIC DATA BASE

CODE OF ACCOUNTS
EXAMPLE OF LEVELS OF DETAIL

No. of Digits	No. of Account	Name of Account	Function/Level
2	26	Main Condenser Heat Rejection System	Name/Account
3	262	Mechanical Equipment	Name/Sub-Account
4	262.1	Heat Rejection System	Name/System
5	262.15	Main Cooling Tower Make-up and Blowdown System	Name/Sub-System
6	262.151	Make-up Water System	Name/Sub-Sub-System
7	262.1511	Rotating Machinery	Class/Equipment Category
8	262.15111	Make-up Pump and Motor	Class/Equipment Sub-Category
9	262.151111	Make-up Pump	Class/Component

<u>Note</u>: The final account, in this case the 9th digit, is the line item where specific equipment and material technical and/or cost information is recorded. At levels above the 9th digit, cost information is collected from lower level accounts and recorded as the summation of the lower level accounts. Depending on the complexity of the system, or the level of detail available, the final account may appear at any digit level from the 5th digit to the 9th digit.

TABLE 2-4

ENERGY ECONOMIC DATA BASE (EEDB)

UNITED ENGINEERS & CONSTRUCTORS INC.

EXAMPLE OF TWO-DIGIT LEVEL COST ESTIMATE

1190 MWe Boiling Water Reactor

Effective Date· January 1, 1978

PLANT CODE 201

COST BASIS 01/78

SUMMARY PAGE 1

ACCT NO **********	ACCOUNT DESCRIPTION **************************	FACTORY EQUIP. COSTS *************	SITE LABOR HOURS ************	SITE LABOR COST *************	SITE MATERIAL COST *************	TOTAL COSTS **************
20 .	LAND AND LAND RIGHTS				2,240,000	2,240,000
21 .	STRUCTURES & IMPROVEMENTS	4,701,306	5832944 MH	73,537,661	51,713,462	129,952,429
22 .	REACTOR PLANT EQUIPMENT	102,937,037	2004126 MH	27,542,217	9,208,372	139,687,626
23 .	TURBINE PLANT EQUIPMENT	97,617,475	1834235 MH	24,908,776	6,055,377	128,581,628
24 .	ELECTRIC PLANT EQUIPMENT	17,382,854	1460367 MH	18,733,008	8,474,410	44,590,272
25 .	MISCELLANEOUS PLANT EQUIPT	8,093,361	330151 MH	4,513,053	1,138,513	13,744,927
26 .	MAIN COND HEAT REJECT SYS	15,093,248	374593 MH	4,908,709	1,422,404	21,424,361
2 .	TOTAL DIRECT COSTS	245,825,281	11836416 MH	154,143,424	80,252,538	480,221,243
91 .	CONSTRUCTION SERVICES	25,460,000	1940000 MH	21,470,000	30,690,000	77,620,000
92 .	HOME OFFICE ENGRG.&SERVICE	91,325,000				91,325,000
93 .	FIELD OFFICE ENGRG&SERVICE	27,600,000			3,430,000	31,030,000
9 .	TOTAL INDIRECT COSTS	144,385,000	1940000 MH	21,470,000	34,120,000	199,975,000
	TOTAL BASE COST	390,210,281	13776416 MH	175,613,424	114,372,538	680,196,243

TABLE 2-5

ENERGY ECONOMIC DATA BASE

INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
(1) System : PWR-U5(LE)/U-T
Start Up : January 1, 1987
Bred Fuel Scenario N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR/YEAR 1985	1990	1995	2000	2005	2010	2015	2020
10	Initial Fuel Loaded	$/KgH								
.11	Uranium Supply	$/KgU								
.111	U_3O_8 Supply	$/lb U_3O_8	45	56	60	62	63	64	65	66
.112	UF_6 Conversion Services	$/KgU as UF_6	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	$/KgH								
.20	Fabrication	$/KgH	177	177	177	177	177	177	177	177
.21	Core Fabrication	$/KgH								
.22	Axial Blanket Fabrication	$/KgH								
.23	Radial Blanket Fabrication	$/KgH								
.30	Shipping to Temporary Storage	$/KgH								
.40	Temporary Storage	$/KgH								
.50	Shipping to Repository	$/KgH	18	18	16	16	16	16	16	16
.60	Disposal of Spent Fuel	$/KgH	134	134	134	134	134	134	134	134

---

(1) See Table 5-21 for System Codes

TABLE 2-6

ENERGY ECONOMIC DATA BASE

OUTPUT NUCLEAR FUEL COST COMPONENTS

No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
(1) System : PWR-U5(LE)/U-T
Start Up : January 1, 1987
Bred Fuel Scenario: N/A

		OUTPUT QUANTITIES, $/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR (2) LEVELIZED
Account No.	Account Description	1	5	10	15	20	25	30	TOTAL $/MBtu
.00	Total	0.67	0.62	0.65	0.67	0.67	0.68	0.68	0.72
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.47	0.50	0.53	0.55	0.55	0.56	0.56	0.59
.111	U_3O_8 Supply								
.112	UF_6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.12	0.07	0.07	0.07	0.07	0.07	0.07	0.08
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
.60	Disposal of Spent Fuel	0.07	0.04	0.04	0.04	0.04	0.04	0.04	0.04

---

(1) See Table 6-21 for System Codes
(2) The column for the 30-year levelized costs includes indirect costs; the other columns do not.

TABLE 2-7

ENERGY ECONOMIC DATA BASE

SUMMARY OF ANNUAL NONFUEL OPERATION AND MAINTENANCE COSTS FOR (PWR) NUCLEAR PLANT

```
SUMMARY OF ANNUAL NONFUEL OPERATION AND MAINTENANCE COSTS
   FOR BASE-LOAD STEAM-ELECTRIC POWER PLANTS IN 1978.0

     PLANT TYPE IS PWR
     WITH EVAPORATIVE COOLING TOWERS
     NUMBER OF UNITS PER STATION 1
     THERMAL INPUT PER UNIT IS 3412. MWT
     PLANT NET HEAT RATE  10221.
     PLANT NET EFFICIENCY, PERCENT   33.38
     EACH UNIT IS 1139. MWE NET RATING
     ANNUAL NET GENERATION, MILLION KWH  6989.
     WITH A PLANT FACTOR OF 0.70

     STAFF, $1000/YR                    5034. (215 PERSONS AT $23412.)

     MAINTENANCE MATERIAL, $1000/YR     1850.
               FIXED                         1850.
               VARIABLE                         0.

     SUPPLIES AND EXPENSES, $1000/YR    4619.
               FIXED                         4200.
               VARIABLE                       419.

     INSURANCE AND FEES, $1000/YR        408.
               COMM. LIAB. INS.               284.
               GOV. LIAB. INS.                 18.
               RETROSPECTIVE PREMIUM            6.
               INSPECTION FEES & EXPENSES     100.

     ADMIN. AND GENERAL, $1000/YR       1662.

     TOTAL FIXED COSTS, $1000/YR                 13153.
     TOTAL VARIABLE COSTS, $1000/YR                419.
     TOTAL ANNUAL O & M COSTS, $1000/YR          13573.

     FIXED UNIT O & M COSTS, MILLS/KWH(E)         1.88
     VARIABLE UNIT O & M COSTS, MILLS/KWH(E)      0.06
     TOTAL UNIT O & M COSTS, MILLS/KWH(E)         1.94
```

TABLE 2-8

ENERGY ECONOMIC DATA BASE

SUMMARY OF ANNUAL NONFUEL OPERATION AND MAINTENANCE COSTS FOR (HSC) COAL PLANT

```
SUMMARY OF ANNUAL NONFUEL OPERATION AND MAINTENANCE COSTS
   FOR BASE-LOAD STEAM-ELECTRIC POWER PLANTS IN 1978.0

     PLANT TYPE IS COAL
     WITH EVAPORATIVE COOLING TOWERS
     NUMBER OF UNITS PER STATION 1
     WITH FGD SYSTEMS
     THERMAL INPUT PER UNIT IS 3299. MWT
     PLANT NET HEAT RATE   9137.
     PLANT NET EFFICIENCY, PERCENT   37.34
     EACH UNIT IS 1232. MWE NET RATING
     ANNUAL NET GENERATION, MILLION KWH  7560.
     WITH A PLANT FACTOR OF 0.70

     STAFF, $1000/YR                    5800. (259 PERSONS AT $22394.)

     MAINTENANCE MATERIAL, $1000/YR     2449.
               FIXED                         1896.
               VARIABLE                       553.

     SUPPLIES AND EXPENSES, $1000/YR   12879.
               FIXED                         1400.
               VAR.  - PLANT                  378.
                     - ASH & FGD SLUDGE     11101.

     ADMIN. AND GENERAL, $1000/YR        910.

     TOTAL FIXED COSTS, $1000/YR                  10006.
     TOTAL VARIABLE COSTS, $1000/YR               12032.
     TOTAL ANNUAL O & M COSTS, $1000/YR           22038.

     FIXED UNIT O & M COSTS, MILLS/KWH(E)          1.32
     VARIABLE UNIT O & M COSTS, MILLS/KWH(E)       1.59
     TOTAL UNIT O & M COSTS, MILLS/KWH(E)          2.92


     HEATING VALUE OF COAL, BTU/LB       11026.
     COAL BURNED, TONS/YEAR            3132283.
     PERCENT ASH                         11.60
     COST OF ASH DISPOSAL, $/TON          4.00
     PERCENT SULFUR                       3.50
     SULFUR (ORIGINAL),TONS/YR          109630.
     TONS LIMESTONE PER TON SULFUR        4.00
     TONS/YEAR LIMESTONE                438520.
     COST OF LIMESTONE, $/TON            10.00
     COST OF SLUDGE DISPOSAL, $/DRY TON  12.00
```

Effective Date - 1/1/78

TABLE 2-9

ENERGY ECONOMIC DATA BASE

COST BASES FOR POWER PLANT CAPITAL COST ESTIMATES

Include:

Site Characteristics - Middletown, USA

Code of Accounts - NUS-531 (Expanded)

Detailed Statement of Bases:

- Cost Date
- Applicable Regulations
- Applicable Codes & Standards
- Plant Design Description

Exclude:

Owner's Cost (Consultants, Site Selection, etc.)

Fees and Permits (Federal, State, Local)

State and Local Taxes

Allowance for Funds Used During Construction

Escalation

Contingency

Owner's Discretionary Items

- Switchyard and Transmission Costs
- Generator Step-up Transformer
- Waste Disposal Costs
- Spare Parts
- Initial Fuel Supply
- Nuclear Liability and Other Insurance

SECTION 3

3.0 ASSUMPTIONS AND GROUND-RULES FOR INITIAL COST UPDATE

3.1 EFFECTIVE DATE OF EEDB INITIAL UPDATE

The effective (cost and regulatory basis) date of this report is January 1, 1978.

3.2 COST PARAMETER GROUND-RULES

3.2.1 Base Costs

Base costs are developed in constant January 1, 1978 dollars, and are presented in the following forms:

a. Capital Costs

- o Present Costs(\$) = Direct plus Indirect Costs
- o Capacity Costs(\$/kW) $= \frac{\text{Present Costs(\$)}}{\text{(CAP)}}$
- o Electric Energy Costs(m/kWh) $= \frac{\text{(Present Costs(\$))(1000 mills/\$)}}{\text{(CAP)(CF)(365 d/y)(24 h/d)}}$ FCR

b. Fuel Costs

- o Thermal Energy Costs (TEC) (¢/MBtu)
- o Electric Energy Costs (m/kWh) = (TEC)(HR)(10 mills/¢)/(10^6)

c. Operating and Maintenance Costs

- o Present Annual Costs (PAC) (\$/y)
- o Electric Energy Costs(m/kWh) $= \frac{\text{(PAC)(1000 mills/\$)}}{\text{(CAP)(CF)(365 d/y)(24 h/d)}}$ LF

where:

CAP = Net Electrical Capacity in kWe*
(Net Power to Generator Step-Up Transformer)

CF = Capacity Factor in % +

FCR = Fixed Charge Rate in %/y+

HR = Net Station Heat Rate in Btu/kWh*

LF = Levelization Factor

*These values are summarized for each model in Tables 4-1 and 4-2.
+These values are given in subsection 3.2.2.

3.2.2 Cost Parameters(1)

Cost parameters used are as follows:

Capacity Factor	70.0% (assumed)
Fixed Charge Rate (Inflation-Free)	10.56%/y(2)
Escalation Rate (Inflation-Free)	e_i = 0%/y(3)
Return on Investment	ROI = 5.42%/y(2)
Discount Rate (Inflation-Free)	x_1 = 4.45%/y(3)
Levelization Period (Fuel Cycle and O&M)	30 years (assumed)
Levelization Factor (O&M)	1(4)

Notes:

1. Although costs reported in this update are derived on an inflation-free basis (e_i = 0%/y, x_1 = 4.45%/y), Nuclear Fuel Cycle Costs are also developed for inflated discount rates based upon 6%, 7% and 8%/y interest rate inflators, as discussed in Section 6.

2. A discussion of the development of these economic parameters are found in Appendix C1.

3. The escalation component, e_s, related to fuel material scarcity, is greater than zero for fuels as discussed in Section 2.3.2.

4. A discussion of the development of this economic parameter may be found in Section 7.

3.2.3 Commercial Operation Dates

A commercial operation date is selected for each plant model to provide a basis for selecting fuel costs for the fuel cycle cost models. This is necessary because fuel costs escalate due to scarcity, as discussed in Section 2.

Commercial operation dates are assumed to be January 1 of the year indicated below. Case I represents a sequential scenario with start-up of plants occurring in the year when the technology is assumed to be ready. Case II is a scenario for the earliest year when all of the technologies are assumed to be ready.

The BWRs and PWRs are the only full scale nuclear plants currently operating on a commercial basis in the United States. For this reason, the costs of the Light Water Reactors are included for the earliest study date, January 1, 1978. Four of the coal-fired generating stations are currently operational and the costs for these are also given for January 1, 1978. It is assumed that the technology supporting the other nuclear plant types will mature at later dates. Data are also provided for the Light Water Reactors in 1987 because it is assumed that two of the coal plant options will be operational by that date: CGCC and CLIQ. Costs projected to 2001 are given for all the nuclear and coal comparison plants.

EEDB Model Number	Model Type	Commercial Operation Dates Case I	Case II
A1	BWR	1978/1987	2001
A2	HTGR	1995	2001
A3	PWR	1978/1987	2001
A4	PHWR	1995	2001
B1	GCFR	2001	2001
B2	LMFBR	2001	2001
C1	HS12	1978	2001
C2	HS8	1978	2001
C3	LS12	1978	2001
C4	LS8	1978	2001
D1	CGCC	1987	2001
D2	CLIQ	1987	2001

3.3 TECHNICAL MODEL GROUND-RULES

3.3.1 General Ground-Rules

General assumptions and ground-rules for the technical models in the Base Data Studies and Reports listed in Table 1-3 are given below. Except for the cost and regulation effective date of January 1, 1978, the same assumptions and ground-rules apply to the Initial Update of the EEDB.

a. Cost data is based on prices effective as of January 1, 1978.

b. A full complement of licensing and design criteria circa January 1, 1978 are utilized. Safety classifications, seismic categories and design codes for major structures and equipment are given in the Base Data Studies and Reports listed in Table 1-3.

c. The detailed technical models are developed for a single unit with sufficient land area to accommodate an identical second unit.

d. The design of the main heat rejection systems are based upon the use of mechanical draft wet and dry (HTGR only) cooling towers. The nuclear ultimate heat sinks are also based on mechanical draft wet cooling towers.

e. The design utilizes two independent offsite sources of power; one at 500 kV and the other at 230 kV.

f. The design life for nuclear power generating stations (NPGS) is 40 years and for fossil power generating stations (FPGS) is 30 years; however, useful operating life is considered as 30 years for each.

g. Generating stations are base-loaded during the first part of their design life.

3.3.2 Specific Ground-Rules

Specific assumptions and ground-rules for each of the technical models of the Base Data Studies and Reports listed in Table 1-3 are given below. The same assumptions and ground-rules apply to these technical models for the Initial Update of EEDB, with some modifications. Details of these modifications are given in subsection 5.4.

3.3.2.1 Boiling Water Reactor (BWR) NPGS - Base Data Study

a. Plant design is based on the General Electric Technical Reference Plant Design, the General Electric Standard Safety Analysis Report (GESSAR), the General Electric 238 Inch Reactor Pressure Vessel (RPV) Nuclear Island Study Arrangements, and UE&C experience.

b. The reactor plant design is based upon the General Electric documents listed in paragraph a. above.

3.3.2.2 High Temperature Gas Cooled Reactor (HTGR) NPGS - Base Data Study

a. Plant design is based on the "3360 MWt HTGR - Steam Cycle Reference Plant Design" study, performed by UE&C for General Atomic Company.

b. Reactor plant design is based on a 3360 MWt, 1330 MWe, 950°F, 2430 psig HTGR Nuclear Steam Supply System, developed by General Atomic Company for the study listed in paragraph a. above.

c. Helium inventory is not included.

d. This HTGR NPGS is a twin-unit plant, located on a site in Eastern Pennsylvania with 0.6 core containerized fuel storage.

3.3.2.3 Pressurized Water Reactor (PWR) NPGS - Base Data Study

a. Plant design is based upon principal technical features corresponding to the Public Service Company of New Hampshire Seabrook Station, circa July, 1976.

b. The reactor plant design is based upon the Westinghouse Reference Safety Analysis Report (RESAR-3S).

3.3.2.4 Pressurized Heavy Water Reactor (PHWR) NPGS - Base Data Study

a. Plant design is based upon the Licensing Assessment Study for a 600 MWe Pressurized Heavy Water Reactor, report number UE&C/ERDA 770630, June, 1977, and scaled-up to a 1162 MWe (3800 MWt) plant.

b. The reactor concept is a three-loop, pressure tube design, heavy-water cooled and moderated type, similar to Canadian design efforts for a 1250 MWe PHWR.

c. Where insufficient information is available, application design data from the NUREG (See Table 1-3) Pressurized Water Reactor NPGS is utilized.

d. Onsite nuclear spent fuel storage capacity is ten years, which is six years greater than for other NPGS listed in Table 1-3.

e. The inventory of heavy-water for moderator and coolant is not included.

3.3.2.5 Gas Cooled Fast Reactor (GCFR) NPGS - Base Data Study

a. Plant design is based upon principal technical features corresponding to the General Atomic Company description of the 750 MWe GCFR, scaled as appropriate to 917 MWe.

b. Other design details were derived from the General Atomic Preliminary Safety Information Document on the 300 MWe Demonstration Plant.

c. Design features, such as the Integrated Support Structure, were derived from optimization studies performed for General Atomic by UE&C.

d. A containment-confinement arrangement is incorporated to meet licensing site suitability source terms which postulate release of plutonium aerosols following a Design Basis Depressurization Accident (DBDA).

e. Design features are incorporated which allow the containment to be totally closed during the refueling operation.

f. Helium inventory is not included.

3.3.2.6 Liquid Metal Fast Breeder Reactor (LMFBR) NPGS - Base Data Study

a. The Base Data includes the designs developed by the three manufacturer/architect-engineer Prototype Large Breeder Reactor (PLBR) study teams, as described in the reference given in Table 1-3.

3.3.2.7 High and Low Sulfur Coal-Fired (HS12, HS8, LS12 and LS8) FPGS - Base Data Study

a. Plant design incorporates a once-through supercritical pressure single reheat type steam generator to supply steam to cross-compound, eight-flow turbines for the 1200 MWe units (HS12 and LS12) and to tandem-compound, four-flow turbines for the 800 MWe units (HS8 and LS8).

b. The steam generators for the high sulfur coal-fired plants (HS12 and HS8) are designed for a high sulfur Eastern coal, and for the low sulfur coal-fired plants (LS12 and LS8) a low sulfur Western coal, as described in Table 4-2.

c. Each plant coal handling system is designed to unload a 100-car, unit train in five hours. The design provides indoor coal storage silos with a capacity sufficient for eight hours consumption at maximum rated capacity and an outdoor storage area with a capacity sufficient for 60 days consumption at maximum rated capacity.

d. Plant design for each high sulfur coal-fired plant (HS12 and HS8) includes a lime scrubber system for removal of sulfur-dioxide (SO_2) from the flue gas.

3.3.2.8 Coal Gasification Combined Cycle (CGCC) FPGS - Base Data Study

a. Plant design is based on the reference process given in Table 1-3.

3.3.2.9 Coal Liquefaction (CLIQ) Plant - Base Data Study

a. Plant design is based on the reference process given in Table 1-3.

3.4 FUEL CYCLE COSTS GROUND-RULES

3.4.1 Nuclear Power Generating Stations

a. Operating life of nuclear plants are taken to be 30 years. Costs of individual expense items are given in the year of their occurrence and are levelized over the plant life record.

b. Mass flow and related data are based upon NASAP (Nonproliferation Alternative Systems Assessment Program) information.

c. Costs of current interest are those for "Throwaway" cycles for the thermal reactors and plutonium recycle for the breeder reactors. (Costs for other cycles are given in Appendix E-1).

d. It is assumed that reprocessing of spent fuel is introduced when breeders are phased into use. Prior to that time, spent fuel elements from "throwaway" cycles are assumed to be shipped to a Federal repository.

e. Costs of onsite storage facilities for spent fuel are included in the plant capital costs in the Capital Cost Models.

f. It is assumed that plutonium bred from U-238 in breeder cycles has no economic value.

g. It is assumed that tails assay for enrichment is 0.2 percent by weight of U-235.

h. No credit is given for advanced isotope separation processes.

3.4.2 Fossil Power Generating Stations

a. Timing in coal cost is estimated.

b. Coal costs for plants starting up on January 1, 1978 do not reflect the results of the 1978 first quarter compensation settlement of the United Mine Workers strike. These additional cost effects are included in coal costs for plant startups in 1987 and 2001.

c. Coal cost data are derived from the sources listed below:

1. Messing, R. F. and Harris, H. E.: "Comparative Energy Values to 1990," Report No. R770602, Impact Securities Corp., (Subsidiary), Arthur D. Little, Inc., Cambridge, MA 02140, June 1977.

2. Browne, Thomas E., et al. (Seven Authors): "Supply 77-EPRI Annual Energy Supply Forecasts," Report No. EA-634-SR, Electric Power Research Institute, Palo Alto, CA 94304, May 1978.

3. Private Communication - "Estimates of Baseline Delivered Coal Costs" (PWC Job No. 3592) - Paul Weir Co., 20 North Wacker Drive, Chicago, IL 60606, October 13, 1978.

4. Private Communication - "Average Steam Coal Prices and Transportation Costs for Two Hypothetical Plant Sites," Internal Memorandum, United Engineers & Constructors Inc., Philadelphia, PA 19101, Job No. 6740.030, C. M. Valorie to A. J. Karalis, August 22, 1978.

5. Monthly Energy Review, U.S. Department of Energy, Energy Information Administration, Washington, DC 20461 (Monthly Through June 1979).

SECTION 4

4.0 SUMMARY OF INITIAL COST UPDATE

4.1 TECHNICAL SUMMARY

The current status of the Technical Models Base Parameters for the Initial Update is summarized in Table 4-1 for Nucleaar Power Generating Stations and Table 4-2 for Comparison Plants. These summaries present a listing of important or key parameters that establish the technical envelope of each plant.

4.2 FUEL CYCLE SUMMARY

Mass flows selected for each of the nuclear plants are presented in Table 4-3. Much of this data was derived from Non-proliferation Alternative Systems Assessment Program (NASAP) information. NASAP calculations are based on a capacity factor of 75 percent, while the capacity factor selected for the EEDB is 70 percent. However, review of sensitivity of Fuel Cycle Costs to such a change in capacity factor revealed that the impact on alternative comparisons would be negligible.

4.3 COST SUMMARY

Capital, Fuel Cycle, and Operating and Maintenance Costs are summarized for all plants, for their respective capacities, in Table 4-4. Tables 4-5 and 4-6 summarize the same data for all plants, except that the capital and O&M costs are normalized to the same net electrical and thermal capacities respectively. Table 4-7 lists footnotes for Tables 4-4, 4-5 and 4-6. The direct cost for each plant account at the two-digit level is normalized by using the following relationship and the appropriate scaling factor:

$$\frac{C_1}{C_2} = \left(\frac{P_1}{P_2}\right)^n \qquad (5)$$

where:

C_1 = Plant 1 Account Cost

C_2 = Plant 2 Account Cost

P_1 = Plant 1 Capacity

P_2 = Plant 2 Capacity

n = Scaling Factor

Since the indirect costs are directly proportional to the direct costs, the indirect costs are normalized by applying the following relationship:

$$\frac{C_{I1}}{C_{I2}} = \frac{C_{D1}}{C_{D2}} \tag{6}$$

where:

C_{I1} = Plant 1 Total Indirect Cost

C_{I2} = Plant 2 Total Indirect Cost

C_{D1} = Plant 1 Total Direct Cost

C_{D2} = Plant 2 Total Direct Cost

Operating and Maintenance costs are normalized by recalculating the O&M costs from OMCOST with adjusted staffing and materials inputs.

Care must be exercised in using the values developed in Table 4-6. At 3800 MWt, current tandem-compound or cross-compound turbine technology is exceeded by the net electric capacity for the HTGR and GCFR plants, and is questionable for the HS12, HS8, LS12 and LS8 plants. Design of such plants in 1978 would require twin turbines with associated increased capital costs for the turbines, turbine pedestals, turbine building, auxiliary systems and equipment and additional steam header piping and valves. Therefore, for 1978, the capital costs in Table 4-7 for these six plants should be increased by 10-20 percent of their respective base direct costs. However, it is anticipated that at some point in the future, required turbine technology will be available for all the base plants and the costs in Table 4-6 will apply providing they are adjusted to then current dollars in the year the technology is available.

4.4 COMMODITY AND MANHOUR SUMMARIES

Commodity summaries for nuclear and fossil power generating stations are given in Tables 4-8 and 4-9 respectively. Site labor summaries by craft are given for nuclear and fossil power generating stations in Tables 4-10 and 4-11 respectively. This information is derived from the data included in the Capital Cost Models for the base plants, which are presented in Section 5.

4.5 SUMMARY OF SIGNIFICANT COST PERTURBATIONS

The Initial Update of the EEDB has evolved from the studies referenced in Tables 1-3 through 1-5, as discussed in Sections 1 and 2. Significant cost regulation and design perturbations have occurred from the time of those referenced studies to the time of this initial update. These perturbations are addressed separately below for capital, fuel cycle, and operating and maintenance costs.

4.5.1 Capital Costs

The direct costs of all the base plants are escalated to January 1, 1978 in accordance with the EEDB Capital Cost Update Procedure described in Appendix C-2. Individual accounts are modified and improved in definition as discussed in subsection 5.4.

Indirect costs are increased in the area of Home Office Engineering and Services account by approximately 100 percent to account for the industry experience that engineering costs during the last several years have been severely understated.

The LMFBR Plant model is based on a "Target Economics" approach. Consequently, capital costs are not evolutionary from previous studies, such as the Prototype Large Breeder Reactor Study, in the usual sense. Rather, target unit costs have been established based on adjustments of previous LMFBR and LWR experience. These adjustments account for the factors that have unnecessarily inflated LMFBR projected costs to date as discussed in subsection 5.4 and Appendix D-2. Resultant target costs reflect a commercial reactor deployed in year 2001, utilizing unit costs and quantities that represent a lower bound of possible LMFBR capital costs.

Proposed revisions to the New Source Performance Standards are expected to require additional scrubbing for the high sulfur coal units and the addition of scrubbers to the low sulfur coal units. Since these new requirements were not implemented by the cost and regulation date of January 1, 1978, they are not applicable, and therefore not reflected, in the Technical and Capital Cost Models of the Initial Update of the EEDB. Adjustments may be made for the estimated impact of these proposed changes by use of the following cost adders and power penalty factors:

EEDB-I Model			Net Power to	Reheat	Direct Cost Adder@	
No.	Type	MWe	GSU* Penalty(MWe)#	Penalty(MWt)#	$\$1978 \times 10^6$	m/kWh
C1	HS12	1232	3.0	30	4.8	0.2
C2	HS8	795	2.8	20	3.3	0.2
C3	LS12	1243	13.4	30	37.1	0.6
C4	LS8	802	9.2	20	26.4	0.7

---

* Generator Step-up Transformer
# Apply to Values in Table 4-2
@ Apply to Values in Table 4-4

4.5.2 Fuel Cycle Costs

Uranium (U_3O_8) cost projections upon which the nuclear fuel cycle costs are based include early long term supply contracts which call for delivery at costs far below the current and expected future market prices. Consequently, the uranium price projections used in the Initial Update of the EEDB may be considered to be at the lower end of projected current and future uranium prices. It is expected that when an adjustment is made in future EEDB updates, U_3O_8 price projections will rise more steeply than actual experience indicates.

Coal costs used for plants that start-up January 1, 1978 do not include the impact of the 1978 coal strike settlement. The coal costs projected for future years take account of the results of the contract settlement reached in early 1978. Because the size of the UMW settlement was significantly greater than the general inflationary rise in the cost of other commodities, a step-rise in coal cost was incorporated in the estimates to establish a new point of departure for calculating the real rise in costs. Therefore, it is anticipated that the next EEDB update will reflect a sharp change in coal prices for plants that start-up in the update year to reflect the coal strike settlement.

4.5.3 Operating and Maintenance Costs

O&M costs reported from OMCOST are refined on a continuous basis by ORNL to reflect the latest factors arising from regulatory and economic considerations. As a result of this continuous refinement, O&M cost projections have risen from previous estimates, and compare more favorably with actual reported experience. It is expected that this trend will continue in future EEDB updates.

Effective Date - 1/1/78

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TABLE 4-1

ENERGY ECONOMIC DATA BASE

NUCLEAR PLANT TECHNICAL MODELS BASE PARAMETER SUMMARY

Model Key Elements	BWR	HTGR	PWR	PHWR	GCFR	LMFBR
General Site	Middletown* Appendix A-1					
Operation	Base Load					
Cost Estimate Ref. Date	January 1, 1978					
Plant Life, Years	30 Years					
Number of Units	Single	Single	Single	Single	Single	Single
Net Power to GSU+	1190 MWe	1330 MWe	1139 MWe	1162 MWe	917 MWe	1390 MWe
Net Plant Heat Rate, Btu/kWh	10,261	8,390	10,224	11,165	9,005	9,330
Net Plant Efficiency, %	33.26	39.58	33.38	30.56	37.90	36.58
Fuel (Initial Core)	UO_2 3% Enriched	UO_2 + Th 20% Enriched	UO_2 3% Enriched	UO_2 Natural	UO_2 + PuO_2 0.73% Enriched	UO_2 + PuO_2 0.88% Enriched
Nuclear Fuel Storage	5/4 Core	0.3 Core	4/3 Core	4/3 Core	4/3 Core	1/3 Core
LICENSING						
Codes and Standards Reference Year	January 1, 1978					
CIVIL/STRUCTURAL						
Flooding Provision	No Special Provisions					
Turbine Building	Enclosed					
Seismic	SSE 0.25g OBE 0.125g					
Foundations	Rock a) Cat I-Mat b) Non-Cat I-Spread Ftgs.					

---

* Modified to reflect January 1978 criteria

\+ Generator Step-up Transformer

TABLE 4-1

ENERGY ECONOMIC DATA BASE

NUCLEAR PLANT TECHNICAL MODELS BASE PARAMETER SUMMARY

Effective Date - 1/1/78

Sheet 2 of 4

Model Key Elements	BWR	HTGR	PWR	PHWR	GCFR	LMFBR
Containment	Steel Containment w/Reinf. Concrete	Reinforced Concrete w/ Steel Liner	Reinforced Concrete w/ Steel Liner	Reinforced Concrete w/ Steel Liner	Reinforced Concrete w/ Steel Liner	Reinforced Concrete w/ Steel Liner
Turbine Pedestal	High Tuned					
Grade Elevation	18'0"					
Water Table	+ 10'0"					
100 Year Maximum	+ 8'0" 100 yrs. flood					
External Missiles	Tornadoes Only					
MECHANICAL						
Steam Generator Type	Integral with Reactor	Helical Coil	Drum Type Heat Exchanger	Drum Type Heat Exchanger	Helical Coil	Single Wall, Straight Tube Once Through, Combined Evaporator/ Superheater
Primary Coolant Pumps						
Number	2	6	4	6	3	4/4**
Drive	Motor	Turbine	Motor	Motor	Turbine	Motor/Motor**
Flow	42,000 gpm	$2.2\text{x}10^6$lb/h	94,400 gpm	40,600 gpm	$3.1\text{x}10^6$lb/h	86,200 gpm/76,700 gpm
Turbine Generator	Tandem Compound 6 flow, 1800 r/min 43" LSB	Cross Compound 4 flow, 44" LSB 3600/1800 r/min	Tandem Compound 6 flow, 1800 r/min 43" LSB	Tandem Compound 6 flow, 1800 r/min 43" LSB	Tandem Compound 4 flow, 1800 r/min 40" LSB	Cross Compound 8 flow, 3600 r/min 30" LSB
Main Steam Conditions at HP Turbine Inlet						
Pressure, psia	960	2430	975	660	1340	2200
Temperature, F	544	950	544	497	994	850
Flow, 10^6lb/h	13.9	9.3	13.7	14.0	7.6	14.24
Gross Turbine Generator	1235.4 MWe @ 2.5 in-HgA	1360 MWe @ 2.5 in-HgA	1192.4 MWe @ 2.5 in-HgA	1238.1 MWe @ 2.5 in-HgA	940 MWe @ 2.5 in-HgA	1460 MWe @ 2.5 in-HgA
Condensers	3 Single Shell Transverse arrg. Two pass Split water box Single Pressure	1 Single Shell Longitudinal One pass Split water box Single Pressure	3 Single Shell Transverse arrg. Two pass Split water box Single Pressure	3 Single Shell Transverse arrg. Two pass Split water box Single Pressure	2 Single Shell Transverse arrg. Two pass Split water box Single Pressure	4 Single Shell Transverse arrg. Two pass Split water box Single Pressure

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** Primary loop/Secondary loop

TABLE 4-1 Effective Date - 1/1/78

ENERGY ECONOMIC DATA BASE Sheet 3 of 4

NUCLEAR PLANT TECHNICAL MODELS BASE PARAMETER SUMMARY

Model	BWR	HTGR	PWR	PHWR	GCFR	LMFBR
Key Elements						
MECHANICAL (con'd)						
Cooling Tower Design Conditions	Mechanical Wet Evaporative Cooler					
Approach	18 F					
Range	26 F					
Wet Bulb	74 F					
Ultimate Heat Sink (Cooling Tower Type)	Mechanical Wet Evaporative Cooling Tower	Mechanical Wet Evaporative Cooling Tower and Air Blast Heat Exchanger	Mechanical Wet Evaporative Cooling Tower	Mechanical Wet Evaporative Cooling Tower	Mechanical Wet Evaporative Cooling Tower and Air Blast Heat Exchanger	Air Blast Heat Exchangers
Boiler Feed Pumps						
Main: Number-Drive	2-Turbine	2-Turbine	2-Turbine	2-Turbine	2-Turbine	2-Turbine
Other: Number-Service-Drive	1-Start-up-Motor	2-Booster-Turbine	2-Emergency 1-Motor 1-Turbine 1-Start-up-Motor	2-Emergency-Motor	2-Booster-Turbine 3-Emergency-Motor	2-Booster-Motor
Boiler Feed Water Heater						
No. of Open Stages		1 @ 1 train				1 @ 1 train
No. of HP Closed Stages	1 @ 2 trains	1 @ 2 trains and	1 @ 2 trains	2 @ 2 trains	2 @ 2 trains	3 @ 3 trains
No. of LP Closed Stages	4 @ 3 trains and 1 @ 2 trains	3 @ 2 trains	4 @ 3 trains and 1 @ 2 trains	4 @ 3 trains	4 @ 2 trains	4 @ 2 trains
Stages of Reheat	One-Steam Reheat	One-Helium Reheat	One-Steam Reheat	One-Steam Reheat	None	Moisture Separator
ELECTRICAL						
Connection to Offsite Power	1 @ 500 kV 1 @ 230 kV					
Generator						
Power Factor	0.9	0.9	0.9	0.9	0.9	0.9
Short Circuit Ratio	0.58	0.50	0.58	0.58	0.58	0.58
Rating	1,400 MVA	671.7 MVA & 835.8 MVA	1,350 MVA	1,400 MVA	1,050 MVA	2 @ 811 MVA
Generator Disconnect	Load Break Switch					

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TABLE 4-1

ENERGY ECONOMIC DATA BASE

NUCLEAR PLANT TECHNICAL MODELS BASE PARAMETER SUMMARY

Model Key Elements	BWR	HTGR	PWR	PHWR	GCFR	LMFBR
ELECTRICAL (Cont'd)						
Auxillary Power System Voltage	13.8 kV, 4.16 kV and 480 Volts	4.16 kV and 480 Volts	13.8 kV, 4.16 kV and 480 Volts	13.8 kV, 4.16 kV and 480 Volts	4.16 kV and 480 Volts	13.8 kV, 4.16 kV and 480 Volts
Unit Auxiliary Transformer Nameplate Rating***	80 MVA	60 MVA	90 MVA	130 MVA	40 MVA	114 MVA
Reserve Auxiliary Transformer Nameplate Rating***	80 MVA	30 MVA	90 MVA	55 MVA	20 MVA	67 MVA
Control Room Wiring	Wired Directly to Panels in Control Room					
Multiplexing of BOP Cables	None					
Instrumentation	Independent Sensors for Computer Input					

***Total of all transformers at top class of cooling rating.

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TABLE 4-2

ENERGY ECONOMIC DATA BASE

COMPARISON PLANT TECHNICAL MODELS BASE PARAMETER SUMMARY

<table>
<tr><th>Model</th><th>HS12</th><th>HS8</th><th>LS12</th><th>LS8</th><th>CGCC</th><th>CLIQ</th></tr>
<tr><td>Key Elements</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>General Site</td><td colspan="5">Middletown*
Appendix A-2</td><td>Not Available</td></tr>
<tr><td>Operation</td><td colspan="6">Base Load</td></tr>
<tr><td>Cost Estimate Ref. Date</td><td colspan="6">January 1, 1978</td></tr>
<tr><td>Plant Life, Years</td><td colspan="5">30 years</td><td>20 years</td></tr>
<tr><td>Number of Units</td><td colspan="5">Single</td><td>Single - 'Multiple Train'</td></tr>
<tr><td>Net Power to GSU^{+}</td><td>1232 MWe</td><td>795 MWe</td><td>1243 MWe</td><td>802 MWe</td><td>630 MWe</td><td>86,800 Barrels/Day Oil
36 x 10^{6} SCFD Natural Gas</td></tr>
<tr><td>Coal Firing Rate, tons/day</td><td>12,264</td><td>8,208</td><td>17,328</td><td>11,592</td><td>4,680</td><td>30,000</td></tr>
<tr><td>Net Plant Heat Rate, Btu/kWh</td><td>9,147</td><td>9,488</td><td>9,461</td><td>9,816</td><td>8,250</td><td>4,850 (equivalent)</td></tr>
<tr><td>Net Plant Efficiency, %</td><td>37.31</td><td>35.97</td><td>36.07</td><td>34.77</td><td>41.37</td><td>70.37</td></tr>
<tr><td>Fuel</td><td>Eastern Coal
Moisture (% by wt)
11.31

Ultimate Analysis
(% by wt dry)
Carbon 69.33
Hydrogen 4.90
Nitrogen .86
Chlorine .04
Sulfur 3.61
Oxygen 9.64

Calorific Value
(Btu/lb)
As Received 11,026
Dry 12,432</td><td>Same as HS12</td><td>Western Coal
Moisture (% by wt)
31.8

Ultimate Analysis
(% by wt dry)
Carbon 69.3
Hydrogen 5.2
Nitrogen 0.9
Chlorine -
Sulfur 0.5
Oxygen 16.8

Calorific Value
(Btu/lb)
As received 8,164
Dry 11,970</td><td>Same as LS12</td><td>Pittsburgh Steam Coal
Moisture (% by wt)
2.4

Ultimate Analysis
(% by wt dry)
Carbon 75.6
Hydrogen 5.2
Nitrogen 1.3
Chlorine -
Sulfur 2.6
Oxygen 8.0

Calorific Value
(Btu/lb)
As received 13,156
Dry 13,480</td><td>Same as HS12</td></tr>
<tr><td>Coal Delivery</td><td>100 Car Unit Train
@ 5 hr. Max. Turnaround</td><td>100 Car Unit Train
@ 5 hr. Max. Turnaround</td><td>100 Car Unit Train
@ 5 hr. Max. Turnaround</td><td>100 Car Unit Train
@ 5 Hr. Max. Turnaround</td><td>Train
Unloading 8 hrs/day</td><td>Train
Not Available</td></tr>
<tr><td>Coal Storage</td><td colspan="4">60 Days @ Full Load
8 hrs. in Silos</td><td>90 Days @ Full Load
16 hrs. in Silos</td><td>Not Available</td></tr>
</table>

---

*Modified to reflect coal plant siting and January 1978 criteria

+Generator Step-up Transformer

Effective Date - 1/1/78

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TABLE 4-2

ENERGY ECONOMIC DATA BASE

COMPARISON PLANT TECHNICAL MODELS BASE PARAMETER SUMMARY

<table>
<tr><th>Model
Key Elements</th><th>HS12</th><th>HS8</th><th>LS12</th><th>LS8</th><th>CGCC</th><th>CLIQ</th></tr>
<tr><td>CIVIL/STRUCTURAL</td><td colspan="5"></td><td rowspan="16">Not Applicable</td></tr>
<tr><td>Flooding Provision</td><td colspan="5">No Special Provisions</td></tr>
<tr><td>Turbine Building</td><td colspan="5">Enclosed</td></tr>
<tr><td>Boiler House</td><td colspan="5">Enclosed</td></tr>
<tr><td>Seismic</td><td colspan="5">Uniform Bldg. Code Zone 1</td></tr>
<tr><td>Foundations</td><td colspan="5">Spread Footings on Rock</td></tr>
<tr><td>Turbine Pedestal</td><td colspan="5">High Tuned</td></tr>
<tr><td>Grade Elevation</td><td colspan="5">18'0"</td></tr>
<tr><td>Water Table</td><td colspan="5">+10'0"</td></tr>
<tr><td>100 Year Maximum Water Level</td><td colspan="5">+8'0"
100 yrs Flood</td></tr>
<tr><td>MECHANICAL</td><td colspan="5"></td></tr>
<tr><td>Steam Generator Type</td><td>Pulverized Coal Pressurized Furnace</td><td>Pulverized Coal Balanced Draft</td><td>Pulverized Coal Pressurized Furnace</td><td>Pulverized Coal Balanced Draft</td><td>Waste Heat Boiler and Coal Gasifier (Pulverized Coal)</td></tr>
<tr><td>Forced Draft Fan
Number
Drive
Flow, scfm</td><td>
3
Motor
680,000</td><td>
2
Motor
680,000</td><td>
3
Motor
701,000</td><td>
2
Motor
700,000</td><td>
2
Motor
167,000</td></tr>
<tr><td>Induced Draft Fan
Number
Drive
Flow, scfm</td><td>
None</td><td>
2
Motor
900,000</td><td>
None</td><td>
2
Motor
1,100,000</td><td>
None</td></tr>
<tr><td>Number of Pulverizers</td><td>7</td><td>7</td><td>8</td><td>8</td><td>4</td></tr>
<tr><td>Stack Height</td><td colspan="4">750 ft</td><td>270 ft - Main Stack
250 ft - Vent + Flare Stacks</td></tr>
</table>

[redacted]

TABLE 4-2

ENERGY ECONOMIC DATA BASE

COMPARISON PLANT TECHNICAL MODELS BASE PARAMETER SUMMARY

Effective Date - 1/1/78

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Model Key Elements	HS12	HS8	LS12	LS8	CGCC	CLIQ
MECHANICAL (Cont'd)						Not Applicable
SO_2 Scrubber	Lime	Lime	Not Required	Not Required	H_2S Scrubber - Stretford	
Sludge Fixation	On-Site	On-Site	Not Required	Not Required	Not Required	
Sludge Disposal	Trucked Off-Site	Trucked Off-Site	Not Required	Not Required	Not Required	
Turbine Generator	Cross Compound 8 Flow 3600/3600 r/min. 30" LSB	Tandem Compound 4 Flow 3600 r/min. 33.5" LSB	Cross Compound 8 Flow 3600/3600 r/min. 30" LSB	Tandem Compound 4 Flow 3600 r/min. 33.5" LSB	Tandem Compound 2 Flow 3600 r/min. 33.5" LSB	
Main Steam Conditions at HP Turbine Inlet	Supercritical	Supercritical	Supercritical	Supercritical		
Pressure, psia	3515/600	3512/637	3515/600	3512/637	2535/455	
Temperature, F	1000/1000	1000/1000	1000/1000	1000/1000	1000/1000	
Flow, 10^6 lb/h	9.1	5.8	9.1	5.8	2.0	
Gross Turbine Generator Output	1309 MWe @ 2.5/1.7 in-HgA	854 MWe @ 2.5/1.7 in-HgA	1309 MWe @ 2.5/1.7 in-HgA	854 MWe @ 2.5/1.7 in-HgA	655 MWe** 2.0 in-HgA	
Condensers	2 Single Shell Longitudinal Arrgt. One Pass Split Water Box Dual Pressure	1 Single Shell Longitudinal Arrgt. One Pass Split Water Box Dual Pressure	2 Single Shell Longitudinal Arrgt. One Pass Split Water Box Dual Pressure	1 Single Shell Longitudinal Arrgt. One Pass Split Water Box Dual Pressure	1 Single Shell Longitudinal Arrgt. Two Pass Multi-Pressure	
Main Heat Sink	← Mechanical Wet Evaporative Cooling Tower →				Natural Draft Wet Hyberbolic Cooling Tower	
Cooling Tower Design Conditions	← Approach 18°F/Range 26°F/Wet Bulb Temperature 74°F →				Approach 16°F/Range 24°F Wet Bulb Temperature - 74°F	
Boiler Feed Pumps Main: Number - Drive	← 2 - Turbine →					
Other: Number - Service Drive	← 2 - Booster - Motor →				2 - Startup - Motor	
Boiler Feedwater Heaters No. of Open Stages	1 @ 1 Train	1 @ 1 Train	1 @ 1 Train	1 @ 1 Train	1 @ 1 Train	
No. HP Closed Stages	3 @ 3 Trains	2 @ 2 Trains	3 @ 2 Trains	2 @ 2 Trains	None	
No. LP Closed Stages	4 @ 2 Trains	4 @ 2 Trains	4 @ 2 Trains	4 @ 2 Trains	2 @ 1 Train	
Stages of Reheat	← One Boiler Reheat →					

** Steam Turbine - 1 @ 372 MWe @ 2.0 in-HgA
Gas Turbine - 4 @ 70.8 MWe

TABLE 4-2

ENERGY ECONOMIC DATA BASE

COMPARISON PLANT TECHNICAL MODELS BASE PARAMETER SUMMARY

Effective Date - 1/1/78

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<table>
<tr><th>Model
Key Elements</th><th>HS12</th><th>HS8</th><th>LS12</th><th>LS8</th><th>CGCC</th><th>CLIQ</th></tr>
<tr><td>ELECTRICAL</td><td></td><td></td><td></td><td></td><td></td><td rowspan="13">Not Applicable</td></tr>
<tr><td>Connection to Off-Site Power</td><td colspan="4">1 @ 500 kV
1 @ 230 kV</td><td>1 @ 345 kV
1 @ 138 kV</td></tr>
<tr><td>Generator</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Power Factor</td><td>0.9</td><td>0.9</td><td>0.9</td><td>0.9</td><td>0.9</td></tr>
<tr><td>Short Circuit Ratio</td><td>0.58</td><td>0.58</td><td>0.58</td><td>0.58</td><td>-</td></tr>
<tr><td>Rating</td><td>2 @ 722 MVA</td><td>1050 MVA</td><td>2 @ 722 MVA</td><td>1050 MVA</td><td>1 @ 412.2 MVA
4 @ 72.9 MVA</td></tr>
<tr><td>Generator Disconnect</td><td colspan="5">None</td></tr>
<tr><td>Auxiliary Power System Voltage</td><td colspan="4">13.8 kV, 4.16 kV and 480 Volts</td><td>4.16 kV and 480 Volts</td></tr>
<tr><td>Unit Auxiliary Transformer Nameplate Rating ***</td><td>120 MVA</td><td>95 MVA</td><td>101.3 MVA</td><td>81 MVA</td><td>52 MVA</td></tr>
<tr><td>Reserve Auxiliary Transformer Nameplate Rating ***</td><td>60 MVA</td><td>47.5 MVA</td><td>54 MVA</td><td>42.5 MVA</td><td>52 MVA</td></tr>
<tr><td>Control Room Wiring</td><td colspan="5">Wired Directly to Panels in Control Room</td></tr>
<tr><td>Multiplexing of BOP Cables</td><td colspan="5">None</td></tr>
<tr><td>Instrumentation</td><td colspan="5">Independent Sensors for Computer Input</td></tr>
</table>

*** Total of all transformers at top class of cooling rating.

TABLE 4-3

ENERGY ECONOMIC DATA BASE

MASS FLOWS SELECTED FOR NUCLEAR PLANT FUEL CYCLES

Model No.	Nuclear Plant	NASAP Reactor Fuel Type Identification	Raw Data Source
+ A2	HTGR	HTGR-U5(DE)/U/Th - 20% (Throw-away)	GAC
A2	HTGR	HTGR-U5(DE)/U/Th - 20% (Recycle)	GAC
+ A3	PWR*	PWR-U5(LE)/U (Throw-away)	CE
A3	PWR*	PWR-U5(LE) + Pu(RE)/U (Recycle)	CE
A4	PHWR	CANDU-U5(NAT)/U (Throw-away)	CE
+ A4	PHWR	CANDU-U5(SE)/U (Throw-away)	CE
A4	PHWR	CANDU-U5(DE)/U/Th - 20% (Throw-away)	ANL
++ B1	GCFR	GCFR-Pu/U/U/U	GAC
B1	GCFR	GCFR-Pu/U/Th/Th	GAC
++ B2	LMFBR	LMFBR-Pu/U/U/U - HT	HEDL
B2	LMFBR	LMFBR-Pu/U/Th/Th - HT	ANL

LEGEND

ANL	Argonne National Laboratory
CE	Combustion Engineering, Inc.
GAC	General Atomic Company
HEDL	Hanford Engineering Development Laboratory

NOTES:

* BWR data is not available; therefore PWR data will be used for BWR (Model A1) fuel cycle costs

\+ Fuel Cycle Costs in Tables 4-5, 4-6 and 4-7 are based on these "Throwaway" cycles

++ The FBR Fuel Cycle Costs in Tables 4-5, 4-6, and 4-7 show reactors using U-238 as fertile material

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TABLE 4-4

ENERGY ECONOMIC DATA BASE

COST UPDATE SUMMARY ($1978)(1)

(See Table 4-7 for Footnotes)

			Capital Cost(4)			Fuel Cycle Costs						O&M Costs	
						1978 Startup(5)		Variable Startup		2001 Startup(6)			
Model	MWt	MWe	$\$10^6$	\$/kW	m/kWh	¢/MBtu	m/kWh	¢/MBtu	m/kWh	¢/MBtu	m/kWh	$\$10^6$/y	m/kWh
BWR	3578	1190	680	571	9.9	70(d)	7.2	72(e)	7.4(e)	76	7.8	13.6	1.9
HTGR	3360	1330	744	559	9.6	*	*	75(f)	6.3(f)	76	6.4	12.9	1.6
PWR	3412	1139	662	581	10.0	70	7.2	72(e)	7.4(e)	76	7.8	13.6	1.9
PHWR	3800(a)	1162	751	646	11.2	*	*	72(f)	8.0(f)	73	8.2	16.8	2.4
GCFR	2419	917	682	744	12.8	*	*	*	*	45	4.1	15.3	2.7
LMFBR	3800	1390	1002	721	12.4	*	*	*	*	39	3.6	17.6	2.1
HS12	3298	1232	523	424	7.3	142	13.0	*	*	222	20.3	22.0	2.9
HS8	2208	795	370	465	8.0	142	13.5	*	*	222	21.0	18.2	3.7
LS12	3444	1243	453	364	6.3	208	19.7	*	*	295	27.9	10.3	1.4
LS8	2306	802	320	399	6.9	208	20.4	*	*	295	28.9	9.8	2.0
CGCC	1523	630(c)	372	590	10.2	*	*	162(e)	13.5(e)	214	17.8	7.7	1.4
CLIQ	*	*	1232	*	*	*	*	170(e,g)	*	222(g)	*	#	*

---

* Not Applicable
\# Not Available

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TABLE 4-4

ENERGY ECONOMIC DATA BASE

COST UPDATE SUMMARY ($1978)(1)

(See Table 4-7 for Footnotes)

Model	MWt	MWe	TOTAL ENERGY COSTS BY YEAR OF START-UP (m/kWh)			
			1978	1987	1995	2001
BWR	3578	1190	19.0	19.2	*	19.6
HTGR	3360	1330	*	*	17.5	17.6
PWR	3412	1139	19.1	19.3	*	19.7
PHWR	3800	1162	*	*	21.6	21.8
GCFR	2419	917	*	*	*	19.6
LMFBR	3800	1390	*	*	*	18.1
HS12	3298	1232	23.2	*	*	30.5
HS8	2208	795	25.2	*	*	32.7
LS12	3444	1243	27.4	*	*	35.6
LS8	2306	802	29.3	*	*	37.8
CGCC	1523	630	*	*	*	29.4

---

* Not Applicable

Effective Date - 1/1/78
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TABLE 4-5

ENERGY ECONOMIC DATA BASE

NORMALIZED(2) COST UPDATE SUMMARY ($1978)(1)

(See Table 4-7 for Footnotes)

			Capital Cost(4)			Fuel Cycle Costs						O&M Costs	
						1978 Startup(5)		Variable Startup		2001 Startup(6)			
Model	MWt	MWe(2)	$\$10^6$	$/kW	m/kWh	¢/MBtu	m/kWh	¢/MBtu	m/kWh	¢/MBtu	m/kWh	$\$10^6/y$	m/kWh
BWR	3424	1139	666	585	10.1	70(d)	7.2	72(e)	7.4(e)	76	7.8	13.6	1.9
HTGR	2878		694	609	10.5	*	*	75(f)	6.3(f)	76	6.4	12.9	1.8
PWR	3412		662	581	10.0	70	7.2	72(e)	7.4(e)	76	7.8	13.6	1.9
PHWR	3727		744	653	11.3	*	*	72(f)	8.0(f)	73	8.2	16.8	2.4
GCFR	3005		749	658	11.3	*	*	*	*	45	4.1	15.3	2.2
LMFBR	3114		917	805	13.9	*	*	*	*	39	3.6	17.6	2.5
HS12	3050		491	431	7.4	142	13.0	*	*	222	20.3	22.0	3.1
HS8	3163		496	435	7.5	142	13.5	*	*	222	21.0	22.0	3.1
LS12	3156		422	371	6.4	208	19.7	*	*	295	27.9	10.2	1.5
LS8	3275		426	374	6.4	208	20.4	*	*	295	28.9	10.2	1.5

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* Not Applicable

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TABLE 4-5

ENERGY ECONOMIC DATA BASE

NORMALIZED(2) COST UPDATE SUMMARY ($1978)(1)

(See Table 4-7 for Footnotes)

Model	MWt	MWe	TOTAL ENERGY COSTS BY YEAR OF START-UP (m/kWh)			
			1978	1987	1995	2001
BWR	3424	1139	19.2	19.4	*	19.8
HTGR	2878		*	*	18.6	18.7
PWR	3412		19.1	19.3	*	19.7
PHWR	3727		*	*	21.7	21.9
GCFR	3005		*	*	*	17.6
LMFBR	3114		*	*	*	20.0
HS12	3050		23.5	*	*	30.8
HS8	3163		24.1	*	*	31.6
LS12	3156		27.6	*	*	35.8
LS8	3275		28.3	*	*	36.8

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* Not Applicable

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TABLE 4-6

ENERGY ECONOMIC DATA BASE

NORMALIZED(3) COST UPDATE SUMMARY ($1978)(1)

(See Table 4-7 for Footnotes)

			Capital Cost(4)			Fuel Cycle Costs						O&M Costs	
						1978 Startup(5)		Variable Startup		2001 Startup(6)			
Model	MWt(3)	MWe	$\$10^6$	$/kW	m/kWh	¢/MBtu	m/kWh	¢/MBtu	m/kWh	¢/MBtu	m/kWh	$\$10^6/y$	m/kWh
BWR	3800	1264	699	553	9.5	70(d)	7.2	72(e)	7.4(e)	76	7.8	13.6	1.8
HTGR		1504(b)	788	524	9.0	*	*	75(f)	6.3(f)	76	6.4	13.0	1.4
PWR		1268	695	548	9.4	70	7.2	72(e)	7.4(e)	76	7.8	13.6	1.8
PHWR		1162	751	646	11.1	*	*	72(f)	8.0(f)	73	8.2	16.8	2.4
GCFR		1440(b)	831	577	9.9	*	*	*	*	45	4.1	15.5	1.8
LMFBR		1390	1002	721	12.4	*	*	*	*	39	3.6	17.6	2.1
HS12		1419(b)	587	414	7.1	142	13.0	*	*	222	20.3	23.8	2.7
HS8		1368(b)	577	422	7.3	142	13.5	*	*	222	21.0	23.8	2.8
LS12		1371(b)	491	358	6.2	208	19.7	*	*	295	27.9	10.5	1.3
LS8		1322(b)	482	365	6.3	208	20.4	*	*	295	28.9	10.5	1.3

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* Not Applicable

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TABLE 4-6

ENERGY ECONOMIC DATA BASE

NORMALIZED(3) COST UPDATE SUMMARY ($1978)(1)

(See Table 4-7 for Footnotes)

Model	MWt	MWe	TOTAL ENERGY COST BY YEAR OF START-UP (m/kWh)			
			1978	1987	1995	2001
BWR	3800	1264	18.5	18.7	*	19.1
HTGR		1504	*	*	16.7	16.8
PWR		1268	18.4	18.6	*	19.0
PHWR		1162	*	*	21.5	21.7
GCFR		1440	*	*	*	15.8
LMFBR		1390	*	*	*	18.1
HS12		1419	22.8	*	*	30.1
HS8		1368	23.6	*	*	31.1
LS12		1371	27.2	*	*	35.4
LS8		1322	28.0	*	*	36.5

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* Not Applicable

TABLE 4-7

ENERGY ECONOMIC DATA BASE

COST UPDATE SUMMARY ($1978) (1)

FOOTNOTES FOR TABLES 4-4, 4-5 and 4-6

1. Data in Constant 1978 Dollars (Non-Inflated)

2. Normalized to a Plant Size Providing 1139 MWe (Net); Not Applicable to CGCC or CLIQ

3. Normalized to a Plant Size Providing 3800 MWt (Net); Not Applicable to CGCC or CLIQ

4. Total Base Cost = Direct Cost + Indirect Cost

5. Based on Plant Commercial Operation Date of January 1, 1978

6. Based on Plant Commercial Operation Date of January 1, 2001

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a. Actual MWt = 3802

b. Tandem-Compound or Cross-Compound Turbines are not available in this capacity in 1978; therefore, if Twin-Turbines are utilized, higher capital costs accrue for structures and Turbine Plant Equipment accounts.

c. Four Gas-Turbine-Generators and One Steam-Turbine-Generator

d. BWR Fuel Cycle Data not available; PWR data are used for BWR (Model A1) Fuel Cycle Costs

e. Based on Plant Commercial Operation Date of January 1, 1987

f. Based on Plant Commercial Operation Date of January 1, 1995

g. Based on Eastern High Sulfur Coal; Refer to Table 4-2

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TABLE 4-8

ENERGY ECONOMIC DATA BASE

COMMODITY SUMMARY OF NUCLEAR POWER GENERATING STATION[#]

Model/Rating (MWe)		BWR/1190		HTGR/1330		PWR/1139		PHWR/1162	
Commodity	Unit	Qty.x10^3	$/Unit	Qty.x10^3	$/Unit	Qty.x10^3	$/Unit	Qty.x10^3	$/Unit
Excavation	CY	536	8.80	319	7.85	529	8.90	533	8.90
Reinforcing Steel and Structural Steel	TN	31	1,070.00	27	1,090.00	33	1,096.00	36	1,109.00
Concrete	CY	204	66.00	135	66.95	172	66.35	185	67.60
BOP Pumps (1000 HP and UP)	HP	57	103.00	82	75.00	55	106.00	74	95.00
Piping	LB	6,756	8.40	4,712	17.90	6,806	9.05	6,745	8.32
Wire and Cable	LF	4,550	3.05	4,511	3.00	4,609	3.00	5,174	2.95
Turbine-Generator	LT	-	54.40[*]	-	42.70	-	55.80[*]	-	57.00[*]
Nuclear Steam Supply System	LT	-	62.50[*]	-	164.50[*]	-	64.30[*]	-	97.90[*]

[#] GCFR and LMFBR: Data not available from three-digit level Capital Cost Model

[*] Cost per Unit is in Dollars per Kilowatt ($/kW)

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TABLE 4-9

ENERGY ECONOMIC DATA BASE

COMMODITY SUMMARY OF FOSSIL POWER GENERATING STATIONS#

Model/Rating (MWe)		HS12/1232		HS8/795		LS12/1243		LS8/802	
Commodity	Unit	Qty.x10^3	$/Unit	Qty.x10^3	$/Unit	Qty.x10^3	$/Unit	Qty.x10^3	$/Unit
Excavation	CY	220	6.25	180	6.50	169	5.80	136	6.05
Reinforcing Steel and Structural Steel	TN	36	990.00	28	988.00	28	992.00	22	991.00
Concrete	CY	108	47.00	88	46.75	77	47.25	64	46.95
BOP Pumps and Fans (1000 HP and UP)	HP	115	79.35	75	87.45	104	68.00	66	75.95
Piping	LB	10,748	4.86	6,198	4.57	7,804	5.18	4,139	4.89
Wire and Cable	LF	3,986	3.05	3,421	3.10	3,336	3.05	2,809	3.20
Turbine-Generator	LT	-	50.85*	-	41.50*	-	50.40*	-	41.10*
Fossil Steam Supply System	LT	-	50.20*	-	55.00*	-	50.65*	-	55.90*
Coal, Ash, Precipitator, Scrubber Systems	LT	-	35.40	-	**	-	23.10	-	**

CGCC and CLIQ: Data not available from three-digit level Capital Cost Model

* Cost per Unit is in Dollars per Kilowatt ($/kW)

** Not Applicable

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TABLE 4-10

ENERGY ECONOMIC DATA BASE

SITE LABOR SUMMARY FOR NUCLEAR POWER GENERATING STATIONS[#]

Model/MWe	BWR/1190		HTGR/1330		PWR/1139		PHWR/1162	
Craft	MHx10^3	\$x10^3	MHx10^3	\$x10^3	MHx10^3	\$x10^3	MHx10^3	\$x10^3
Boiler Makers	416	6,185	548	8,148	617	9,174	815	12,119
Carpenters	1,510	18,557	1,042	12,806	1,414	17,378	1,527	18,766
Electricians	1,762	22,765	1,654	21,369	1,733	22,390	1,911	24,690
Ironworkers	1,655	23,534	1,212	17,234	1,372	19,509	1,627	23,135
Laborers	1,426	13,661	1,029	9,857	1,346	12,894	1,454	13,929
Operating Engineers	1,005	14,029	642	8,962	836	11,670	931	12,996
Pipe Fitters	3,002	42,658	1,991	28,292	2,903	41,251	3,085	43,837
Others	1,060	12,754	1,278	20,971	908	10,866	1,004	10,958
TOTAL	11,836	154,143	9,396[@]	127,639	11,129	145,132	12,354	160,430
MH/kW	10.0		7.1[@]		9.8		10.6	

[#] GCFR and LMFBR: Data not available from three-digit Capital Cost Model

[@] These numbers do not include the labor hours for erection of the Pre-stressed Concrete Reactor Vessel

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TABLE 4-11

ENERGY ECONOMIC DATA BASE

SITE LABOR SUMMARY FOR FOSSIL POWER GENERATING STATIONS[#]

Model/MWe	HS12/1232		HS8/795		LS12/1243		LS8/802	
Craft	MHx10^3	$\$x10^3$	MHx10^3	$\$x10^3$	MHx10^3	$\$x10^3$	MHx10^3	$\$x10^3$
Boiler Makers	222	3,301	166	2,468	210	3,122	154	2,289
Carpenter	390	4,793	319	3,920	269	3,306	219	2,691
Electricians	1,482	19,147	1,278	16,511	1,222	15,788	1,093	14,121
Ironworkers	934	13,281	722	10,266	734	10,437	564	8,020
Laborers	617	5,910	494	4,732	631	6,044	494	4,732
Operating Engineers	610	8,515	447	6,240	494	6,896	357	4,983
Pipe Fitters	2,370	33,677	1,504	21,371	1,796	25,521	1,102	15,659
Others	2,296	29,532	1,590	20,355	2,020	26,063	1,400	17,979
TOTAL	8,921	118,156	6,520	85,863	7,376	97,177	5,383	70,474
MH/kW	7.2		8.2		5.9		6.7	

[#] CGCC and CLIQ: Data not available from three-digit level Capital Cost Model

SECTION 5

5.0 CAPITAL COST INITIAL UPDATE

The Initial Update of the Capital Costs in the Energy Economic Data Base is accomplished in two distinct steps. The first step is the assembly of the data base as described in Sections 1 and 2, followed by evaluation and adjustment of the technical models to assure that they reflect current changes in state-of-the-art designs, regulations, codes and standards. The second step is the adjustment of the capital cost models to reflect escalation, and to accommodate the technical model revisions. This section of the report presents the detailed results of the capital cost update followed by a description of the changes to the technical and capital cost models which support it.

5.1 CAPITAL COST UPDATE PROCEDURE

A specific capital cost update procedure is developed for the EEDB, and is described in Appendix C-2. This update procedure is utilized for the selected technical models given in Tables 1-1 and 1-2 to develop the Capital Cost Initial Update.

5.2 CAPITAL COST SUMMARY

Capital costs are prepared for the EEDB as Base Construction Costs, which are the sum of the Direct and Indirect Capital Costs. Base costs include those cost elements listed in Table 2-9, as discussed in Section 2. Direct, Indirect and Base Capital Costs are summarized for all plants in Table 5-1. Tables 5-2 and 5-3 also summarize the same data for all plants, except that the capital costs are normalized to the same net electrical and thermal capacities, respectively. The normalization process is discussed in subsection 4.3

The net electrical capacity chosen for normalization is the PWR NPGS technical model so that capital costs of the other technical models can be compared to this most frequently chosen industry cost base. The net thermal capacity chosen for normalization is the maximum licensable NPGS thermal rating of 3800 MWt so that costs can be compared on the basis of maximum economy of scale.

5.3 DETAILED CAPITAL COSTS, COMMODITIES AND MANHOURS

Results of the Capital Cost Initial Update are presented for each technical plant model at the two-digit and three-digit cost-code-of-accounts level in Tables 5-4 through 5-15 as follows:

Nuclear Plant Models	Table Number	Fossil Plant Models	Table Number
BWR	5-4	HS12	5-10
HTGR	5-5	HS8	5-11
PWR	5-6	LS12	5-12
PHWR	5-7	LS8	5-13
GCFR	5-8	CGCC	5-14
LMFBR	5-9	CLIQ	5-15

Except for the CLIQ Fossil Plant Model, the first sheet of each table is a two-digit tabulation and the following four sheets are the three-digit tabulation for each plant model. Only a two-digit tabulation is included for CLIQ, because currently available information will not support additional detail.

Additional detail, down to the nine-digit cost-code-of-accounts level, is available in the Backup Data File, as discussed in subsection 2.2. A total on the order of 10,000 computer sheets of cost detail is available from this file.

Commodities, including materials, equipment and craft labor manhours are tabulated for each technical plant model in Tables 5-16 through 5-23 as follows:

Nuclear Plant Models	Table Number	Fossil Plant Models	Table Number
BWR	5-16	HS12	5-20
HTGR	5-17	HS8	5-21
PWR	5-18	LS12	5-22
PHWR	5-19	LS8	5-23

Tabulations for GCFR and LMFBR Nuclear Plant Models and for CGCC and CLIQ Fossil Plant Models are not included because they have not yet been sufficiently detailed to produce this information. When necessary information becomes available to expand the technical models for GCFR, LMFBR, CGCC and CLIQ to the required degree of detail, they will be included in the data base.

5.4 TECHNICAL MODEL UPDATE

The Base Data Studies and Reports listed in Table 1-3 were reviewed and modified in accordance with the EEDB update procedure described in Appendix C-2. Subsection 3.3 gives the assumptions and ground-rules for each of the technical models of the Base Data Studies and Reports. Subsection 5.4 discusses the detailed modifications of each of the Base Data Studies and Reports technical models that are required for the Initial Update of the EEDB to the cost and regulation date of January 1, 1978. The applicable Base Data Study or Report, together with the appropriate modifications listed, comprise the technical models for the Initial Update of the Energy Economic Data Base. The material presented in this section is organized to correspond to the uniform cost-code-of-accounts used in the EEDB and the Base Data Studies and Reports.

In addition to the specific modifications described in the following pages, other modifications are made on a general basis, as required, to improve system performance, operability and constructibility.

5.4.1 EEDB Model Number A1, Model Type BWR, EEDB Initial Update

Base Data Study: Commercial Electric Power Cost Studies - Capital Cost - Boiling Water Reactor Plant (NUREG-0242, COO-2477-6)

ACCOUNT 214 Security Building

Plant security is revised to meet the requirements of Regulatory Guide 1.17, "Protection of Nuclear Plants Against Industrial Sabotage" (Revision 1, 6/73). The security building and upgraded security system are added to meet plant physical security requirements as currently interpreted by UE&C. The building provides a controlled means of access to the plant to prevent industrial sabotage or the theft of nuclear materials. It is a reinforced concrete, Seismic Category I, structure located at grade. The building is 53 feet wide, 63 feet long and one story or 20 feet high, with a volume of approximately 66,800 cubic feet.

The upgraded security system costs are included in Account 253.22.

ACCOUNT 218A Control Room/Diesel-Generator Building

The control building and electrical tunnels are modified to meet the requirements of Regulatory Guide 1.120, "Fire Protection Guidelines for Nuclear Power Plants" (Revision 1, 11/77). The control building is modified by adding a fourth floor above the control room for cable spreading. This modification provides over and under cable spreading areas for the control room which allows each electrical channel to have its own spreading area separated by three-hour rated fire walls. The electrical tunnels are also modified to separate each channel with three-hour rated fire walls.

ACCOUNT 218T Ultimate Heat Sink Structure

The ultimate heat sink basin capacity is increased from 7 to 30 days storage to meet the requirements of Regulatory Guide 1.27, "Ultimate Heat Sinks for Nuclear Power Plants" (Revision 2, 1/76). No change is made to the superstructure which includes the north and south bays and cooling towers.

ACCOUNT 224 Radwaste Processing

The liquid, gaseous and solid waste systems are upgraded to improve system performance and operability.

ACCOUNT 225 Fuel Handling and Storage

The spent fuel pool cooling system is changed from one loop with redundant components to two separate redundant loops. This revision is made to preclude the loss of spent fuel pool cooling in the event of a pipe or valve failure in a single loop.

ACCOUNT 226 Other Reactor Equipment

The boron recycle system is upgraded, consistent with changes made to the liquid radwaste system (see Account 224 above), to improve system performance and operability.

ACCOUNT 234 Feed Heating System

The two turbine driven boiler feed-water pumps are increased from 57 percent capacity to 80 percent capacity each to prevent reactor trip from the loss of one pump.

ACCOUNT 252 Air, Water and Steam Service System

The plant fire protection system is modified to meet the requirements of the additional floor in the control building and additional separation in the electrical tunnels (see Account 218A above).

ACCOUNT 253 Communications Equipment

The communications system is modified to meet the requirements of the additional floor in the control building and additional separation in the electrical tunnels (see Account 218A above). The security system is revised to meet the requirements of Regulatory Guide 1.17 (see Account 214 above).

5.4.2 EEDB Model Number A2, Model Type HTGR, EEDB Initial Update

Base Data Study: 3360 MWt HTGR-Steam Cycle Reference Plant Design
(General Atomic Company-SC 558623)

ACCOUNT 211 Yardwork

The Yardwork account is modified to adjust for the "Middletown" site conditions described in Appendix A-1 and a single unit design versus the first of two units design of the Base Data Study. Excavation quantities are changed to reflect a rock site from the firm soil site of the Base Data Study.

ACCOUNT 214 Security Building

Same as subsection 5.4.1, BWR, Account 214 modification.

ACCOUNT 215 Reactor Service Building, ACCOUNT 217 Fuel Storage Building ACCOUNT 218E Helium Storage Area, ACCOUNT 218I Access Building, ACCOUNT 218S Holding Pond, ACCOUNT 261.1 Makeup Water Intake and Discharge Structures

These structures are reduced in size to reflect a single unit design. Fuel storage is set at 0.3 core in containerized fuel modules.

ACCOUNT 224 Radwaste Processing, ACCOUNT 225 Nuclear Fuel Handling and Storage

These systems and components are reduced in size and/or number to reflect a single unit design.

ACCOUNT 226 Other Reactor Plant Equipment

The helium storage and transfer system is reduced in size to reflect a single unit design. The nuclear service water cross connection between Units 1 and 2 is deleted.

ACCOUNT 233 Condensing System

The bulk chemical storage tanks for the condensate polishing system are reduced in capacity to reflect a single unit design.

ACCOUNT 24 Electric Plant Equipment

Offsite power connections are changed from 345 kV and 115 kV to 500 kV and 230 kV respectively.

ACCOUNT 252 Auxiliary Water and Steam Service System

The auxiliary steam system interconnecting piping between Units 1 and 2 is deleted.

5.4.3 EEDB Model Number A3, Model Type PWR, EEDB Initial Update

Base Data Study: Commercial Electric Power Cost Studies - Capital Cost - Pressurized Water Reactor Plant (NUREG-0241, COO-2477-5)

ACCOUNT 214 Security Building

Same as subsection 5.4.1, BWR, Account 214 modification.

ACCOUNT 218A Control Room/Diesel-Generator Building

Same as subsection 5.4.1, BWR, Account 218A modification.

ACCOUNT 218T Ultimate Heat Sink Structure

Same as subsection 5.4.1, BWR, Account 218T modification.

ACCOUNT 224 Radwaste Processing

Same as subsection 5.4.1, BWR, Account 224 modification. Additionally, a flash tank and pumps are added to the steam generator blowdown system to balance steam flow rates from the steam generators.

ACCOUNT 225 Fuel Handling and Storage

Same as subsection 5.4.1, BWR, Account 225 modification.

ACCOUNT 226 Other Reactor Plant Equipment

Same as subsection 5.4.1, BWR, Account 226 modification.

ACCOUNT 234 Feed-Heating System

Same as subsection 5.4.1, BWR, Account 234 modification.

ACCOUNT 252 Air, Water and Steam Service System

Same as subsection 5.4.1, BWR, Account 252 modification.

ACCOUNT 253 Communications Equipment

Same as subsection 5.4.1, BWR, Account 253 modification.

5.4.4 EEDB Model Number A4, Model Type PHWR, EEDB Initial Update

Base Data Study: Commercial Electric Power Cost Studies - Capital Cost - Pressurized Heavy Water Reactor Plant (COO-2477-13)

ACCOUNT 211 Yardwork

Excavation quantities are reduced to reflect replacement of PWR scaled buildings with unique PHWR design buildings.

ACCOUNT 212 Reactor Containment Building, ACCOUNT 215 Reactor Service and Fuel Handling Building

Material quantities are revised to reflect replacement of PWR scaled buildings with unique PHWR design buildings.

ACCOUNT 214 Security Building

Same as subsection 5.4.1, BWR, Account 214 modification.

ACCOUNT 218A Control Room/Diesel-Generator Building

Same as subsection 5.4.1, BWR, Account 218A modification.

ACCOUNT 218T Ultimate Heat Sink Structure

Same as subsection 5.4.1, BWR, Account 218T modification.

ACCOUNT 23 Turbine Plant Equipment, ACCOUNT 24 Electric Plant Equipment, ACCOUNT 25 Miscellaneous Plant Equipment, ACCOUNT 26 Main Condenser Heat Rejection System

System design is revised to reflect replacement of PWR designs with unique PHWR designs based on ongoing DOE studies.

5.4.5 EEDB Model Number B1, Model Type GCFR, EEDB Initial Update

Base Data Study: Capital Cost - Gas Cooled Fast Reactor Plant
(COO-2477-16)

ACCOUNT 212 Reactor Containment Building

Design of secondary containment is modified to improve constructibility and decrease cost.

ACCOUNT 214 Security Building

Same as subsection 5.4.1, BWR, Account 214 modification.

ACCOUNT 222 Main Heat Transfer System

Estimate for manhours to install steam generators is improved.

ACCOUNT 223 Safeguards Cooling System

Design conservatism is reduced to reflect current practice by replacing two 100 percent pumps in each of two loops of the Core Auxiliary Cooling Water (CACW) system with one 50 percent pump per loop.

ACCOUNT 226 Other Reactor Plant Equipment

Design of Reactor Plant Cooling Water (RPCW) system is improved to reflect current practice by adding one RPCW heat exchanger.

ACCOUNT 227 Instrumentation and Control

Instrumentation and Control quantities are revised to reflect current practice for reactor plant diagnostic and instrumentation tubing.

ACCOUNT 233 Condensing System

Instrumentation and Control material and labor manhours for the condensate polishing system are reduced to reflect current practice.

ACCOUNT 234 Feed Heating System

Design conservatism is reduced to reflect current practice by deleting one of four emergency feed-water pumps and drives. Labor manhours for installation of a booster pump is increased to provide technical model consistency.

ACCOUNT 237 Turbine Plant Miscellaneous Items

Pipe Insulation, Account 237.31, is deleted to provide technical model consistency and eliminate double accounting. Pipe insulation is included in the individual piping system accounts.

5.4.6 EEDB Model Number B2, Model Type LMFBR, EEDB Initial Update

Base Data Study: Technical Comparison of Prototype Large Breeder Reactor (PLBR) Phase II Competing Designs (31-109-38-3547)

In the case of the LMFBR, the Base Data Studies could not be used directly as for the other Nuclear Plant Models for the following reasons:

1. PLBR Phase II Competing Designs were not structured in a uniform code-of-accounts for either technical or cost tabulation.
2. PLBR Phase II Competing Designs varied widely and were, therefore, difficult to compare or consolidate.
3. Quantities, commodities and costs varied widely and appeared to be overly conservative for an nth-of-a-kind plant when compared at the component level with other reactor types.

For the purposes of the EEDB Initial Update, it was desirable to include an LMFBR NPGS based on target costs of a commercially viable reactor, deployed in a time frame when the target goals have a high probability of being realized.

LMFBR NPGS Target Economics Philosophy

For the LMFBR NPGS to become an economically viable concept, certain cost criteria need to be met. Namely, the sum of the three cost factors contributing to energy cost (Capital, Fuel Cycle, and O&M) must combine to provide an energy cost equal to or less than competing forms of energy production.

The Light Water Reactor Nuclear Power Generating Station as represented by the PWR NPGS is chosen as the present competition for the LMFBR NPGS. The current EEDB goal is to eliminate cost over-conservatism and cost uncertainties which have prevailed over the past few years by developing a commercial cost estimate for a LMFBR NPGS, based upon an nth-of-a-kind unit, designed to commercial type nuclear standards and regulations. The year 2001 is selected as the target date when the LMFBR NPGS should become competitive. This date takes into account the present research and development requirements of the concept, as well as allowing for the predicted increase in the cost of uranium to a minimum value of \$62 per pound (in constant \$1978), where a break-even point is more likely.

A review of Tables 4-6 and 5-3 provides insight into the required relative target cost of the LMFBR vs. the PWR to achieve a m/kWh break-even energy cost. A goal of LMFBR NPGS capital cost equal to about 1.25 times the PWR cost is established. This ratio equates to a maximum delta of approximately 135 \$/kWe (in \$1978) by which the Base Construction Cost of a 3800 MWt LMFBR NPGS can exceed that of a PWR NPGS of the same thermal capacity.

To achieve these goals a set of target costs is established which, if met, would create a competitive LMFBR. The largest legally licensable plant (3800 MWt) is selected since the economy of scale will have a positive effect in achieving the goal. Basic ground-rules to govern the cost estimating are also established to ensure that the costs reflect a realistic commercial concept within the bounds of current regulations.

The method utilized to evaluate and control the costs is to compare the LMFBR cost estimates on a commodity basis, such as \$/Ft^2, \$/HP, etc., with that of the PWR. When a significant difference is noted without reasonable technical justification, additional attention is focused to bring the cost to a reasonable value. In this manner, costs estimated on an overly-pessimistic basis can be improved.

In future work, an effort should be made to define concept improvements, which although not necessarily licensable at the present time, can reasonably be assumed to be licensable by the year 2000. Items such as expansion joints instead of expansion loops in sodium piping and new cost saving materials need to be evaluated for further cost improvements.

LMFBR NPGS Cost Basis

To implement the Target Economics philosophy, a 1390 MWe, loop type, LMFBR central station power plant is selected for the study. Using the experience gained from the Base Data Studies, UE&C designed the Balance of Plant systems, and retained Combustion Engineering, Inc. to develop a Nuclear Steam Supply System, in accordance with the above philosophy.

The plant design incorporates a 3800 MWt (1390 MWe), 850°F, 2200 psig LMFBR Nuclear Steam Supply System, which is described in Combustion Engineering, Inc. Report CE-FBR-78-532, "NSSS Capital Costs for a Mature LMFBR Industry." A copy of this report may be found in Appendix D-1.

Further discussion of the Target Economics Philosophy for the LMFBR NPGS is included in Appendix D-2.

A plant size of 3800 MWt is selected to achieve the maximum benefit of economy of scale within the current regulatory limit. Other design features to minimize costs that are incorporated, within the limits of current regulatory requirements, are as follows:

- The safety related NSSS buildings are clustered around the containment building and share a common base mat founded on rock.

- The reactor plant incorporates four primary and four secondary loops with four intermediate heat exchangers and four primary and four secondary pumps. Four primary loop check valves are located within the reactor vessel.
- The steam generation system is of the Benson Cycle type, utilizing two single wall tube steam generators for each of the four loops.
- The turbine plant consists of a cross-compound turbine with four double flow low pressure stages. The inlet conditions to the high pressure turbine are 850°F @ 2200 psia.
- The safety related decay heat removal function is fulfilled by two 100 percent Auxiliary Heat Transfer Systems which cool the primary sodium directly from the reactor vessel without requiring the primary loops to be operating.
- The secondary loops provide no emergency function and are classified non-nuclear downstream of the external isolation valves at the containment.
- The steam generators are classified as non-nuclear, and the steam generator buildings are non-Seismic Category I.
- Fuel handling is of the "under-the-head" type with 1/3 core storage inside the containment structure, isolated from the primary containment volume to permit fuel transfer during normal reactor operations.
- Guard vessels for the primary system have been eliminated by the utilization of filler block around the reactor vessel, and siphon breaker lines.

For the EEDB Initial Update sodium, NaK and Dowtherm inventories are not included.

Results

The LMFBR/PWR capital cost ($/kW basis) ratio goal of 1.25 is not realized during this first attempt at target economics. However, a cost ratio of 1.32 (refer to Table 5-3) is achieved. This ratio achieves a slightly lower than break-even cost for the LMFBR vs. the PWR, because a uranium cost of approximately $62 per pound (constant $1978) is used in the fuel cycle study for the year 2001. (Refer to Table 4-7)

5.4.7 EEDB Model Number C1, Model Type HS12, EEDB Initial Update EEDB Model Number C3, Model Type LS12, EEDB Initial Update

Base Data Study: Commercial Electric Power Cost Studies - Capital Cost - High and Low Sulfur Coal Plants - 1200 MWe (Nominal) (NUREG-0243, COO-2477-7)

ACCOUNT 219 Stack Structure

The stack height is increased from 600 feet to 750 feet to meet the requirements of the Clean Air Act Amendments of 1977. The stack structure is changed from a brick to steel liner due to the increase in height.

ACCOUNT 223 Ash and Dust Handling System

The ash and dust handling systems are upgraded to improve system performance and operability.

ACCOUNT 233 Condensing Systems

The condenser design is upgraded to improve system heat rate.

Licensability

As discussed in subsection 4.5.1, these coal-fired power plants are not designed to meet the proposed revisions to the emission standards current on January 1, 1978. However, cost adders are given in subsection 4.5.1 to permit the adjustment of the EEDB Initial Update capital costs, to reflect the impact of including these proposed changes.

It should be pointed out, there is some doubt that coal-fired power plants designed to meet emission standards requirements current for January 1, 1978, can be sited where desired in all cases. The most desirable location may be a lightly to heavily industrialized area. For such sites, where topographical features are not optimum, there is a probability that additional capital expenditures may be required for the plant to remain in compliance continuously. Appendix D-3 addresses this subject in greater detail. No attempt has been made, during this initial update, to predict levels of potential additional capital expenditure requirements, because the emission standards are currently in a state of change.

5.4.8 EEDB Model Number C2, Model Type HS8, EEDB Initial Update EEDB Model Number C4, Model Type LS8, EEDB Initial Update

Base Data Study: Commercial Electric Power Cost Studies - Capital Cost - Low and High Sulfur Coal Plants - 800 MWe (Nominal) (NUREG-0244, COO-2477-8)

ACCOUNT 219 Stack Structures

Same as subsection 5.4.7, HS12/LS12, Account 219 modification.

ACCOUNT 223 Ash and Dust Handling System

Same as subsection 5.4.7, HS12/LS12, Account 223 modification.

ACCOUNT 233 Condensing System

Same as subsection 5.4.7, HS12/LS12, Account 233 modification.

Licensability

Same as subsection 5.4.7, HS12/LS12, Licensability.

5.4.9 EEDB Model Number D1, Model Type CGCC, EEDB Initial Update

Base Data Study: Study of Electric Plant Applications for Low Btu Gasification of Coal for Electric Power Generation (FE-1545-59)

The technical description and cost estimate for the coal gasification power plant are based on a conceptual balance-of-plant study performed by UE&C for Combustion Engineering, Inc. This study has been extended to a complete plant under the Energy Economic Data Base program. Combustion Engineering provided costs and design data for several systems.

Combustion Engineering has been developing this concept since 1970, supported in part by the Department of Energy and the Electric Power Research Institute. A process demonstration unit is now operating, and demonstration plant preliminary designs are being prepared.

Except for the gasification process unit and the gas turbines, all plant components are readily available commercial equipment which are commonly used in power plants or natural gas processing facilities. The gasifier itself is very similar to pulverized coal-fired boilers. The gas turbines utilize current technology but are not now on the market. Because the plant produces elemental sulfur as a by-product, the environmental effects are significantly less than direct coal-fired plants with SO_2 scrubbers.

Technical Description

This plant is a combined cycle electric power plant which is fired by gasified coal. The coal is gasified in an air-blown, entrained bed gasifier. The resulting gas, which has a low heating value, is cleaned and the sulfur is removed using the Stretford process. The clean gas is compressed and burned in gas turbines, which generate a total of 283 MWe. The exhaust gas from the gas turbines passes through waste heat boilers to produce steam, which drives a 372 MWe steam turbine-generator. The net plant output is 630 MWe.

The net station heat rate is 8250 Btu/kWh. Plant thermal efficiency is about 41 percent.

Coal Handling System

The coal handling system is standard for a power plant of this size. Railroad cars dump to a hopper-type unloader. The coal is stacked out, reclaimed by lowering wells, crushed, and pulverized. Thaw sheds, car shakers, and distribution and sampling systems are included. Coal storage space holds a 90-day reserve.

The plant uses 195 tons per hour of Pittsburgh Steam coal (13,480 Btu/lb-Dry, 2.6 percent sulfur, 2.4 percent moisture). However, the entrained bed gasifier can handle most types of coal.

Ash Handling System

The ash handling system is a standard system handling 18 tons per hour of molten slag.

Gasifier

The two gasifiers are air-blown, entrained bed gasifiers. They are similar to standard water-wall boilers and have superheater and reheater sections. The gasifier provides about one-half of the steam produced in the plant.

The gasifier produces 2.3 million pounds per hour of fuel gas, a mixture of carbon monoxide, carbon dioxide, methane, hydrogen, and nitrogen. Sulfur in the gas is 90 percent H_2S and 10 percent carbonyl sulfide (COS). The heating value of the gas is assumed to be about 110 Btu/SCF, although recent pilot plant data has been reported in the 120 to 140 Btu/SCF range.

Gas Clean-up System

Cyclones remove most of the particulates in the raw gas, which are recycled into the gasifier. Fine cleaning is accomplished with a wet scrubber, with wastes recycled to the gasifier. The H_2S is then removed by the Stretford process. About 90 tons per day of elemental sulfur are produced, with a small waste stream, which is also recycled to the gasifier.

In this plant, the COS is burned with the fuel gas, producing SO_2 which is released. Because only 10 percent of the sulfur occurs as COS, the plant will comply with regulations requiring 90 percent sulfur removal. If this level of SO_2 removal violates future regulations, the COS can be shifted to H_2S before Stretford processing.

Gas Turbine-Generators

Four gas turbine-generator units compress and burn the fuel gas, with a net output of 70.8 MWe each. The gas turbines are rated at an inlet temperature of 2200°F, which is somewhat higher than currently available turbines. Reducing the inlet temperature would cause a reduction in plant efficiency.

Waste Heat Boilers

Four waste heat boilers convert the exhaust heat to steam. Primary steam production is about 500,000 lb/hr at 2600 psig and 1000°F. Reheat to 1000°F is included, and low pressure steam is produced in another section.

Steam Turbine-Generator

The standard steam turbine-generator system produces 372 MWe. The design steam flow is 1.99 million pounds per hour, with a back pressure of 2.0 inches of mercury. The generator is rated at 410 MVA.

Cooling System

The main cooling system utilizes a wet, natural draft, hyperbolic cooling tower, approximately 300 feet in diameter and 400 feet high.

Waste Treatment

The waste treatment system handles the relatively small quantity of waste from the cooling and ash handling systems. The system includes filtration, neutralizing, and a sediment basin.

Economic Description

The costs estimated for the coal gasification combined cycle power plant are an extension of studies performed for DOE and EPRI by Combustion Engineering, Inc. United Engineers & Constructors Inc. estimated balance-of-plant costs for C-E.

The cost design basis is not entirely consistent with the other plants estimated for the EEDB Initial Update; however, the differences are considered to be negligible.

5.4.10 EEDB Model Number D2, Model Type CLIQ, EEDB Initial Update

Base Data Study: Recycle SRC Processing for Liquid and Solid Fuels,
Gulf Mineral Resources Company

Clean, low-sulfur fuels refined from coal are an alternative to converting oil-fired plants to coal firing and to adding sulfur scrubbers to existing coal-fired plants. The Department of Energy is sponsoring several processes, but is presently giving priority to development and demonstration of the Solvent Refined Coal (SRC) process.

The SRC process has been developed by Gulf Mineral Resources Company over the past 15 years. Several versions have been tested in the 50 ton/day pilot plant near Tacoma, Washington. The SRC-I solid fuel process has been further developed by Southern Services Company, which is now designing a demonstration plant. Gulf has further improved the process, using part of the product slurry to dissolve the coal rather than a distillate liquid as in SRC-I. This revised process, known as Recycle SRC, can be used to produce solid or liquid or a combination of clean fuels.

The Recycle SRC process has a somewhat higher efficiency than SRC-I, is more reliable, and presents fewer technical problems, relying more on current technology. In addition, the ability to produce a variety of products, in somewhat variable quantities, allows a large plant to vary its production in response to market demands and thereby operate the plant at maximum economic efficiency.

Technical and economic data is largely proprietary to the process developers. Cost data is published only in summary form. Because of the proprietary nature of the data, it is not possible to obtain cost and technical data from DOE or the process developers. The limited scope of the EEDB Initial Update does not allow development of a reference plant design and cost estimate. Thus, the plant and costs which are described here are taken from the most recent published data from Gulf Mineral Resources Company.(1)

A more detailed description of the Solvent Refined Coal Process appears in Appendix D-4.

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(1) Recycle SRC Processing for Liquid and Solid Fuels, B. K. Schmid and D. M. Jackson, Gulf Mineral Resources Company, June 1978.

5.5 COST MODEL UPDATE

5.5.1 Direct Costs

Modifications to equipment, material and craft labor man-hours and associated costs are made, as required, to reflect the Technical Model modifications described in subsection 5.4 above. Additionally, adjustments are made to reflect January 1, 1978 labor practices and productivity to arrive at new labor costs based on both the modified and unmodified labor hours. Total direct costs are, therefore, revised accordingly.

5.5.2 Indirect Costs

Modifications to Construction Services (Account 91) and Field Office Engineering and Services (Account 93) are made to reflect changes in direct craft labor hour costs and current field practice. Modifications to Home Office Engineering and Services (Account 92) are made to reflect changes in direct Factory Equipment Costs and current industry realization that engineering man-hour estimates have traditionally been lower than actual. The latter is due to the escalation of regulations, codes and standards as the job progresses. To provide for this, engineering manhours and associated costs in the Base Studies and Reports of Table 1-3 are significantly increased for the EEDB Initial Update.

Effective date - 1/1/78

TABLE 5-1

ENERGY ECONOMIC DATA BASE

CAPITAL COST UPDATE SUMMARY
($1978 x 10^6) (a)

	Nuclear Plant Models						Comparison Plant Models					
Model	BWR	HTGR	PWR	PHWR	GCFR	LMFBR	HS12	HS8	LS12	LS8	CGCC	CLIQ (c)
MWt	3578	3360	3412	3800 (b)	2419	3800	3298	2208	3444	2306	1523	N/A
MWe	1190	1330	1139	1162	917	1390	1232	795	1243	802	630	N/A
Direct Cost	480	557	466	540	470	737	434	304	378	264	303	*
Indirect Cost	200	187	196	211	212	265	89	66	75	56	69	*
Base Cost	680	744	662	751	682	1002	523	370	453	320	372	1232
$/kW	571	559	581	646	744	721	424	465	364	399	590	N/A

N/A Not Applicable
* Data Not Available
(a) Data in Constant $1978 (Non-Inflated)
(b) Actual MWt = 3802
(c) 86,800 bbl/d 0.1; 36 x 10^6 SCFD Natural Gas

Effective Date - 1/1/78

TABLE 5-2

ENERGY ECONOMIC DATA BASE

NORMALIZED[a] CAPITAL COST UPDATE SUMMARY ($1978 x 10^6)[b]

	Nuclear Plant Models						Comparison Plant Models[c]			
Model	BWR	HTGR	PWR	PHWR	GCFR	LMFBR	HS12	HS8	LS12	LS8
MWt	3424	2878	3412	3727	3005	3114	3050	3163	3156	3275
MWe	← 1139 →						← 1139 →			
Direct Cost	470	519	466	535	519	672	407	408	352	352
Indirect Cost	196	175	196	209	230	245	84	88	70	74
Base Cost	666	694	662	744	749	917	491	496	422	426
$/kW	585	609	581	653	658	805	431	435	371	374
Cost Ratio ($/kW)	1.01	1.05	1.00	1.12	1.13	1.39	0.74	0.75	0.64	0.64

(a) Normalized to a plant size providing 1139 MWe (Net)
(b) Data in Constant $1978 (Non-Inflated)
(c) Normalization not Applicable to CGCC and CLIQ Comparison Plant Models

TABLE 5-3

ENERGY ECONOMIC DATA BASE

NORMALIZED(a) CAPITAL COST UPDATE SUMMARY
(\$1978 x 10^6)(b)

	Nuclear Plant Models						Comparison Plant Models(c)			
Model	BWR	HTGR	PWR	PHWR	GCFR	LMFBR	HS12	HS8	LS12	LS8
MWt	← 3800 →						← 3800 →			
MWe	1264	1504(d)	1268	1162	1440(d)	1390	1419(d)	1368	1371	1322
Direct Cost	494	589	490	540	578	737	487	474	410	398
Indirect Cost	205	199	205	211	253	265	100	103	81	84
Base Cost	699	788	695	751	831	1002	587	577	491	482
\$/kW	553	524	548	646	577	721	414	422	358	365
Cost Ratio (\$/kW)	1.01	0.96	1.00	1.18	1.06	1.32	0.76	0.77	0.65	0.67

(a) Normalized to a plant size of 3800 MWt or its equivalent
(b) Data in Constant \$1978 (Non-Inflated)
(c) Normalization Not Applicable to CGCC and CLIQ Comparison Plant Models
(d) Tandem-Compound or Cross-Compound Turbines are not available in this capacity in 1978; therefore, if Twin Turbines are utilized, higher capital costs accrue for Structures and Turbine Plant Equipment accounts

Table 5-4

1190 MWe Boiling Water Reactor NPGS

Capital Cost Estimate

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UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1190 MWE BOILING WATER REACTOR

SUMMARY PAGE 1
11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
20 .	LAND AND LAND RIGHTS				2,240,000	2,240,000
21 .	STRUCTURES & IMPROVEMENTS	4,701,306	5832944 MH	73,537,661	51,713,462	129,952,429
22 .	REACTOR PLANT EQUIPMENT	102,937,037	2004126 MH	27,542,217	9,208,372	139,687,626
23 .	TURBINE PLANT EQUIPMENT	97,617,475	1834235 MH	24,908,776	6,055,377	128,581,628
24 .	ELECTRIC PLANT EQUIPMENT	17,382,854	1460367 MH	18,733,008	8,474,410	44,590,272
25 .	MISCELLANEOUS PLANT EQUIPT	8,093,361	330151 MH	4,513,053	1,138,513	13,744,927
26 .	MAIN COND HEAT REJECT SYS	15,093,248	374593 MH	4,908,709	1,422,404	21,424,361
2 .	TOTAL DIRECT COSTS	245,825,281	11836416 MH	154,143,424	80,252,538	480,221,243
91 .	CONSTRUCTION SERVICES	25,460,000	1940000 MH	21,470,000	30,690,000	77,620,000
92 .	HOME OFFICE ENGRG.&SERVICE	91,325,000				91,325,000
93 .	FIELD OFFICE ENGRG&SERVICE	27,600,000			3,430,000	31,030,000
9 .	TOTAL INDIRECT COSTS	144,385,000	1940000 MH	21,470,000	34,120,000	199,975,000
	TOTAL BASE COST	390,210,281	13776416 MH	175,613,424	114,372,538	680,196,243

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UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
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ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
20 .	LAND AND LAND RIGHTS				2,240,000	2,240,000
211.	YARDWORK	185,662	448383 MH	5,137,265	5,162,305	10,485,232
212.	REACTOR CONTAINMENT BLDG	1,088,359	1918783 MH	25,252,478	18,593,568	44,934,405
213.	TURBINE ROOM + HEATER BAY	1,280,063	1186709 MH	14,883,157	12,291,881	28,455,101
214.	SECURITY BUILDING	35,968	33183 MH	420,076	272,353	728,397
215.	AUXILIARY BLDG + TUNNELS	306,163	377945 MH	4,630,501	2,236,784	7,173,448
216.	WASTE PROCESS BUILDING	146,530	308752 MH	3,830,133	2,146,088	6,122,751
217.	FUEL STORAGE BLDG	110,160	362837 MH	4,648,123	2,884,665	7,642,948
218A.	CONTROL RM/D-G BUILDING	938,018	695898 MH	8,520,922	4,269,219	13,728,159
218B.	ADMINISTRATION+SERVICE BLG	564,281	190119 MH	2,473,159	2,028,901	5,066,341
218D.	FIRE PUMP HOUSE,INC FNDTNS	18,557	10890 MH	137,269	86,847	242,673
218K.	PIPE TUNNELS		21740 MH	261,979	118,297	380,276
218S.	HOLDING POND		8092 MH	96,692	42,395	139,087
218T.	ULTIMATE HEAT SINK STRUCT	27,545	259096 MH	3,128,860	1,532,075	4,688,480
218V.	CONTR RM EMG AIR INTK STR		10517 MH	117,047	48,084	165,131
21 .	STRUCTURES & IMPROVEMENTS	4,701,306	5832944 MH	73,537,661	51,713,462	129,952,429

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1190 MWE BOILING WATER REACTOR

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ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
220A.	NUCLEAR STEAM SUPPLY(NSSS)	74,382,000				74,382,000
220B.	NSSS OPTIONS					
221.	REACTOR EQUIPMENT	575,540	517502 MH	7,192,534	3,701,074	11,469,148
222.	MAIN HEAT XFER XPORT SYS.	316,689	170578 MH	2,356,271	231,096	2,904,056
223.	SAFEGUARDS SYSTEM	5,763,442	422668 MH	5,828,039	601,451	12,192,932
224.	RADWASTE PROCESSING	8,328,302	280124 MH	3,871,150	1,144,900	13,344,352
225.	FUEL HANDLING + STORAGE	1,240,919	58840 MH	811,571	112,436	2,164,926
226.	OTHER REACTOR EQUIP.	4,548,573	327417 MH	4,510,310	1,431,197	10,490,080
227.	INSTRUMENTATION + CONTROL	7,781,572	76411 MH	974,189	82,210	8,837,971
228.	REACTOR PLANT MISC ITEMS		150586 MH	1,998,153	1,904,008	3,902,161
22 .	REACTOR PLANT EQUIPMENT	102,937,037	2004126 MH	27,542,217	9,208,372	139,687,626
231.	TURBINE GENERATOR	63,346,817	426159 MH	5,614,858	1,327,926	70,289,601
233.	CONDENSING SYSTEMS	11,480,703	281240 MH	3,905,403	861,689	16,247,795
234.	FEED HEATING SYSTEM	10,012,011	375753 MH	5,182,082	519,031	15,713,124
235.	OTHER TURBINE PLANT EQUIP.	11,554,640	584834 MH	8,095,751	997,495	20,647,886
236.	INSTRUMENTATION + CONTROL	1,223,304	49980 MH	636,902	63,681	1,923,887
237.	TURBINE PLANT MISC ITEMS		116269 MH	1,473,780	2,285,555	3,759,335
23 .	TURBINE PLANT EQUIPMENT	97,617,475	1834235 MH	24,908,776	6,055,377	128,581,628

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PLANT CODE 201   COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1190 MWE BOILING WATER REACTOR

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
241.	SWITCHGEAR	5,397,600	62761 MH	817,823	84,827	6,300,250
242.	STATION SERVICE EQUIPMENT	10,435,724	103178 MH	1,340,673	243,307	12,019,704
243.	SWITCHBOARDS	493,000	10371 MH	134,864	65,684	693,548
244.	PROTECTIVE EQUIPMENT		76040 MH	975,836	481,000	1,456,836
245.	ELECT.STRUC +WIRING CONTNR		575223 MH	7,343,040	2,185,657	9,528,697
246.	POWER & CONTROL WIRING	1,056,530	632794 MH	8,120,772	5,413,935	14,591,237
24 .	ELECTRIC PLANT EQUIPMENT	17,382,854	1460367 MH	18,733,008	8,474,410	44,590,272
251.	TRANSPORTATION & LIFT EQPT	1,684,101	22100 MH	304,221	118,193	2,106,515
252.	AIR,WATER+STEAM SERVICE SY	3,691,282	276938 MH	3,812,730	848,606	8,352,618
253.	COMMUNICATIONS EQUIPMENT	1,741,875	23468 MH	301,170	153,201	2,196,246
254.	FURNISHINGS + FIXTURES	976,103	7645 MH	94,932	18,513	1,089,548
25 .	MISCELLANEOUS PLANT EQUIPT	8,093,361	330151 MH	4,513,053	1,138,513	13,744,927
261.	STRUCTURES	105,352	108872 MH	1,343,141	862,292	2,310,785
262.	MECHANICAL EQUIPMENT	14,987,896	265721 MH	3,565,568	560,112	19,113,576
26 .	MAIN COND HEAT REJECT SYS	15,093,248	374593 MH	4,908,709	1,422,404	21,424,361
2 .	TOTAL DIRECT COSTS	245,825,281	11836416 MH	154,143,424	80,252,538	480,221,243

PLANT CODE 201
COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1190 MWE BOILING WATER REACTOR

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
911.	TEMPORARY CONSTRUCTION FAC		1680000 MH	18,090,000	9,050,000	27,140,000
912.	CONSTRUCTION TOOLS & EQUIP		260000 MH	3,380,000	20,960,000	24,340,000
913.	PAYROLL INSURANCE & TAXES	25,460,000				25,460,000
914.	PERMITS,INS. & LOCAL TAXES				680,000	680,000
915.	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	25,460,000	1940000 MH	21,470,000	30,690,000	77,620,000
921.	HOME OFFICE SERVICES	86,245,000				86,245,000
922.	HOME OFFICE Q/A	3,745,000				3,745,000
923.	HOME OFFICE CONSTRCTN MGMT	1,335,000				1,335,000
92 .	HOME OFFICE ENGRG.&SERVICE	91,325,000				91,325,000
931.	FIELD OFFICE EXPENSES				3,430,000	3,430,000
932.	FIELD JOB SUPERVISION	21,440,000				21,440,000
933.	FIELD QA/QC	3,135,000				3,135,000
934.	PLANT STARTUP & TEST	3,025,000				3,025,000
93 .	FIELD OFFICE ENGRG&SERVICE	27,600,000			3,430,000	31,030,000
9 .	TOTAL INDIRECT COSTS	144,385,000	1940000 MH	21,470,000	34,120,000	199,975,000
	TOTAL BASE COST	390,210,281	13776416 MH	175,613,424	114,372,538	680,196,243

Table 5-5

1330 MWe High Temperature Gas Cooled Reactor NPGS

Capital Cost Estimate

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                                              UNITED ENGINEERS & CONSTRUCTORS INC.                       SUMMARY PAGE    1
 PLANT CODE     COST BASIS                    ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
    343           01/78                       1330 MWE HIGH TEMPERATURE GAS COOLED REACTOR                                11/12/79

                                                 FACTORY          SITE            SITE             SITE              TOTAL
ACCT NO        ACCOUNT DESCRIPTION             EQUIP. COSTS    LABOR HOURS     LABOR COST     MATERIAL COST          COSTS
********** *************************          *************   ************   *************   *************    **************

20 .       LAND AND LAND RIGHTS                                                                  2,240,000          2,240,000

21 .       STRUCTURES & IMPROVEMENTS             3,959,384    3967005 MH      50,249,991        37,654,843         91,864,218

22 .       REACTOR PLANT EQUIPMENT             235,818,892    1834220 MH      25,419,860         2,643,895        263,882,647

23 .       TURBINE PLANT EQUIPMENT              94,227,521    1883086 MH      25,483,555         6,066,422        125,777,498

24 .       ELECTRIC PLANT EQUIP                 14,217,100    1465896 MH      18,275,641         9,218,947         41,711,688

25 .       MISC. PLANT EQUIP                     7,221,201     273752 MH       3,738,788           886,652         11,846,641

26 .       MAIN COND HEAT REJECT SYS            12,731,782     345591 MH       4,471,190         2,185,047         19,388,019


2  .       TOTAL DIRECT COSTS                  368,175,880    9769550 MH     127,639,025        60,895,806        556,710,711


91 .       CONSTRUCTION SERVICES                21,270,000    1720000 MH      19,020,000        27,000,000         67,290,000

92 .       HOME OFFICE ENGRG.&SERVICE           91,325,000                                                         91,325,000

93 .       FIELD OFFICE ENGRG&SERVICE           25,240,000                                       3,040,000         28,280,000


9  .       TOTAL INDIRECT COSTS                137,835,000    1720000 MH      19,020,000        30,040,000        186,895,000



           TOTAL BASE COST                     506,010,880   11489550 MH     146,659,025        90,935,806        743,605,711
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PLANT CODE 343 COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1330 MWE HIGH TEMPERATURE GAS COOLED REACTOR

11/12/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
20 .	LAND AND LAND RIGHTS				2,240,000	2,240,000
211.	YARDWORK	181,258	334808 MH	3,836,316	3,795,018	7,812,592
212.	REACTOR CONTAINMENT BLDG	913,993	1395900 MH	18,538,768	15,178,998	34,631,759
213.	TURBINE ROOM + HEATER BAY	582,471	359824 MH	4,687,927	6,281,480	11,551,878
214.	SECURITY BUILDING	34,560	33018 MH	417,708	271,858	724,126
215.	REACTOR SERVICE BLDG	556,807	321459 MH	3,983,501	2,417,348	6,957,656
217.	FUEL STORAGE BLDG	54,340	88640 MH	1,115,856	800,870	1,971,066
218A.	CONTROL RM/D-G BUILDING	1,233,599	718406 MH	8,814,847	3,606,724	13,655,170
218B.	ADMIN + SERV BLDG	196,997	99786 MH	1,289,494	1,150,040	2,636,531
218D.	FIRE PUMP HOUSE	17,513	10897 MH	137,611	87,316	242,440
218E.	HELIUM STORAGE AREA		26733 MH	311,708	91,647	403,355
218H.	DIES CLG + FL OIL STG BLDG	10,600	87576 MH	1,056,630	460,205	1,527,435
218I.	ACCESS BUILDING	90,880	56181 MH	735,984	657,094	1,483,958
218J.	PIPING PENETRATION VAULTS	27,670	96378 MH	1,195,700	692,069	1,915,439
218S.	HOLDING POND		8092 MH	96,692	42,395	139,087
218T.	ULTIMATE HEAT SINK STRUCT	38,696	321188 MH	3,940,088	2,084,279	6,063,063
218V.	CTL RM EMG AIR IN STR	20,000	8119 MH	91,161	37,502	148,663
21 .	STRUCTURES & IMPROVEMENTS	3,959,384	3967005 MH	50,249,991	37,654,843	91,864,218

PLANT CODE 343

COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1330 MWE HIGH TEMPERATURE GAS COOLED REACTOR

11/12/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
220A.	NUCLEAR STEAM SUPPLY(NSSS)	218,739,000				218,739,000
220B.	NSSS OPTIONS					
221.	REACTOR EQUIPMENT	14,942	791902 MH	11,107,048	727,078	11,849,068
222.	MAIN HEAT TRANS SYS.	180,150	178708 MH	2,599,111	311,778	3,091,039
223.	SAFEGUARDS COOL. SYS.	4,510,979	261550 MH	3,582,451	414,057	8,507,487
224.	RAD WASTE PROCESSING	889,462	59612 MH	822,122	192,600	1,904,184
225.	NUCLEAR FUEL HANDLING + ST	2,378,676	45458 MH	619,031	93,642	3,091,349
226.	OTHER REACTOR PLANT EQUIP	7,695,903	325363 MH	4,479,733	626,996	12,802,632
227.	INSTRUMENTATION + CONTROL	1,409,780	69660 MH	887,900	16,387	2,314,067
228.	REACTOR PLANT MISC ITEMS		101967 MH	1,322,464	261,357	1,583,821
22 .	REACTOR PLANT EQUIPMENT	235,818,892	1834220 MH	25,419,860	2,643,895	263,882,647
231.	TURBINE GENERATOR	52,984,393	469302 MH	6,148,052	1,749,462	60,881,907
233.	CONDENSING SYS.	12,703,508	259484 MH	3,604,598	1,002,434	17,310,540
234.	FEED HEAT. SYS.	9,210,446	217832 MH	3,010,427	461,124	12,681,997
235.	OTHER TURB PLANT EQUIP	18,616,174	822183 MH	11,331,014	2,082,920	32,030,108
236.	INSTRUMENTATION + CONTROL	713,000	47895 MH	610,418	16,983	1,340,401
237.	TURBINE PLANT MISC ITEMS		66390 MH	779,046	753,499	1,532,545
23 .	TURBINE PLANT EQUIPMENT	94,227,521	1883086 MH	25,483,555	6,066,422	125,777,498

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PLANT CODE 343   COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1330 MWE HIGH TEMPERATURE GAS COOLED REACTOR

11/12/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
241.	SWITCHGEAR	5,169,510	63134 MH	783,591	84,451	6,037,552
242.	STATION SERVICE EQUIP	7,825,200	78204 MH	1,011,383	176,453	9,013,036
243.	SWITCHBOARDS	643,840	12290 MH	159,275	14,324	817,439
244.	PROTECTIVE EQUIP		87094 MH	1,118,437	532,100	1,650,537
245.	ELEC STRUC + WIRING CNTNRS		580115 MH	6,881,059	2,076,055	8,957,114
246.	POWER & CONTROL WIRING	578,550	648059 MH	8,321,896	6,335,564	15,236,010
24 .	ELECTRIC PLANT EQUIP	14,217,100	1465896 MH	18,275,641	9,218,947	41,711,688
251.	TRANSPORTATION+LIFT EQUIP	2,220,770	17785 MH	245,086	24,830	2,490,686
252.	AIR WTR+STEAM SERV SYS	2,963,397	223304 MH	3,079,445	800,922	6,843,764
253.	COMMUNICATIONS EQUIP	1,100,368	24786 MH	317,819	27,388	1,445,575
254.	FURNISHINGS + FIXTURES	936,666	7877 MH	96,438	33,512	1,066,616
25 .	MISC. PLANT EQUIP	7,221,201	273752 MH	3,738,788	886,652	11,846,641
261.	STRUCTURES	106,249	107512 MH	1,328,396	844,073	2,278,718
262.	MECHANICAL EQUIPMENT	12,625,533	238079 MH	3,142,794	1,340,974	17,109,301
26 .	MAIN COND HEAT REJECT SYS	12,731,782	345591 MH	4,471,190	2,185,047	19,388,019
2 .	TOTAL DIRECT COSTS	368,175,880	9769550 MH	127,639,025	60,895,806	556,710,711

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PLANT CODE 343

COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1330 MWE HIGH TEMPERATURE GAS COOLED REACTOR

11/12/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
911.	TEMPORARY CONSTRUCTION FAC		1490000 MH	16,030,000	8,010,000	24,040,000
912.	CONSTRUCTION TOOLS & EQUIP		230000 MH	2,990,000	18,200,000	21,190,000
913.	PAYROLL INSURANCE & TAXES	21,270,000				21,270,000
914.	PERMITS,INS. & LOCAL TAXES				790,000	790,000
915.	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	21,270,000	1720000 MH	19,020,000	27,000,000	67,290,000
921.	HOME OFFICE SERVICES	86,245,000				86,245,000
922.	HOME OFFICE Q/A	3,745,000				3,745,000
923.	HOME OFFICE CONSTRCTN MGMT	1,335,000				1,335,000
92 .	HOME OFFICE ENGRG.&SERVICE	91,325,000				91,325,000
931.	FIELD OFFICE EXPENSES				3,040,000	3,040,000
932.	FIELD JOB SUPERVISION	19,080,000				19,080,000
933.	FIELD QA/QC	3,135,000				3,135,000
934.	PLANT STARTUP & TEST	3,025,000				3,025,000
93 .	FIELD OFFICE ENGRG&SERVICE	25,240,000			3,040,000	28,280,000
9 .	TOTAL INDIRECT COSTS	137,835,000	1720000 MH	19,020,000	30,040,000	186,895,000
	TOTAL BASE COST	506,010,880	11489550 MH	146,659,025	90,935,806	743,605,711

Table 5-6

1139 MWe Pressurized Water Reactor NPGS

Capital Cost Estimate

PLANT CODE 148
COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1139 MWE PRESSURIZED WATER REACTOR

11/09/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
20 .	LAND AND LAND RIGHTS				2,240,000	2,240,000
21 .	STRUCTURES + IMPROVEMENTS	6,657,338	5149620 MH	64,783,533	44,719,726	116,160,597
22 .	REACTOR PLANT EQUIPMENT	108,742,229	2046044 MH	28,195,349	9,702,313	146,639,891
23 .	TURBINE PLANT EQUIPMENT	92,726,511	1765723 MH	23,942,209	5,929,779	122,598,499
24 .	ELECTRIC PLANT EQUIPMENT	15,942,593	1443306 MH	18,509,966	8,358,604	42,811,163
25 .	MISCELLANEOUS PLANT EQUIPT	8,575,941	354950 MH	4,854,752	1,178,731	14,609,424
26 .	MAIN COND HEAT REJECT SYS	14,747,018	370058 MH	4,846,310	1,414,379	21,007,707
2 .	TOTAL DIRECT COSTS	247,391,630	11129701 MH	145,132,119	73,543,532	466,067,281
91 .	CONSTRUCTION SERVICES	24,100,000	1870000 MH	20,680,000	29,400,000	74,180,000
92 .	HOME OFFICE ENGRG.&SERVICE	91,325,000				91,325,000
93 .	FIELD OFFICE ENGRG&SERVICE	26,815,000			3,300,000	30,115,000
9 .	TOTAL INDIRECT COSTS	142,240,000	1870000 MH	20,680,000	32,700,000	195,620,000
	TOTAL BASE COST	389,631,630	12999701 MH	165,812,119	106,243,532	661,687,281

PLANT CODE 148   COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1139 MWE PRESSURIZED WATER REACTOR

11/09/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
20 .	LAND AND LAND RIGHTS				2,240,000	2,240,000
211.	YARDWORK	185,662	446438 MH	5,112,051	5,115,507	10,413,220
212.	REACTOR CONTAINMENT BLDG	3,236,937	1633792 MH	21,435,599	14,769,631	39,442,167
213.	TURBINE ROOM + HEATER BAY	461,781	399598 MH	5,212,286	7,260,759	12,934,826
214.	SECURITY BUILDING	35,968	33183 MH	420,076	272,353	728,397
215.	PRIM AUX BLDG + TUNNELS	634,049	495679 MH	6,146,344	3,039,732	9,820,125
216.	WASTE PROCESS BUILDING	184,075	479722 MH	5,857,164	3,025,846	9,067,085
217.	FUEL STORAGE BLDG	361,112	228791 MH	2,966,229	1,707,146	5,034,487
218A.	CONTROL RM/D-G BUILDING	900,843	599941 MH	7,389,504	3,659,155	11,949,502
218B.	ADMINISTRATION+SERVICE BLG	564,281	190119 MH	2,473,159	2,028,901	5,066,341
218D.	FIRE PUMP HOUSE,INC FNDTNS	18,557	10890 MH	137,269	86,847	242,673
218E.	EMERGENCY FEED PUMP BLDG	23,534	139701 MH	1,685,885	593,425	2,302,844
218F.	MANWAY TUNNELS (RCA TUNLS)	1,615	33678 MH	407,333	163,492	572,440
218G.	ELEC. TUNNELS	2,923	374 MH	5,157	2,860	10,940
218H.	NON-ESSEN. SWGR BLDG.	10,813	14745 MH	182,460	136,221	329,494
218J.	MN STEAM + FW PIPE ENC.	7,643	140963 MH	1,723,405	1,118,788	2,849,836
218K.	PIPE TUNNELS		17402 MH	209,715	94,400	304,115
218M.	HYDROGEN RECOMBINER STRUCT		6155 MH	76,619	50,052	126,671
218P.	CONTAIN EQ HATCH MSLE SHLD		9640 MH	115,594	34,120	149,714
218S.	HOLDING POND		8092 MH	96,692	42,395	139,087
218T.	ULTIMATE HEAT SINK STRUCT	27,545	250200 MH	3,013,945	1,470,012	4,511,502
218V.	CONTR RM EMG AIR INTK STR		10517 MH	117,047	48,084	165,131
21 .	STRUCTURES + IMPROVEMENTS	6,657,338	5149620 MH	64,783,533	44,719,726	116,160,597

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
220A.	NUCLEAR STEAM SUPPLY(NSSS)	73,255,000				73,255,000
220B.	NSSS OPTIONS					
221.	REACTOR EQUIPMENT	527,725	87414 MH	1,231,599	2,193,976	3,953,300
222.	MAIN HEAT XFER XPORT SYS.	4,372,381	374014 MH	5,229,771	555,454	10,157,606
223.	SAFEGUARDS SYSTEM	4,493,593	461008 MH	6,359,303	977,944	11,830,840
224.	RADWASTE PROCESSING	6,315,692	249505 MH	3,449,102	749,690	10,514,484
225.	FUEL HANDLING + STORAGE	2,940,858	59857 MH	826,558	112,068	3,879,484
226.	OTHER REACTOR PLANT EQUIP	7,696,381	612702 MH	8,453,064	2,922,927	19,072,372
227.	RX INSTRUMENTATION+CONTROL	7,519,099	53881 MH	687,091	58,475	8,264,665
228.	REACTOR PLANT MISC ITEMS	1,621,500	147663 MH	1,958,861	2,131,779	5,712,140
22 .	REACTOR PLANT EQUIPMENT	108,742,229	2046044 MH	28,195,349	9,702,313	146,639,891
231.	TURBINE GENERATOR	62,299,068	417917 MH	5,503,446	1,316,814	69,119,328
233.	CONDENSING SYSTEMS	11,098,795	271406 MH	3,767,643	846,990	15,713,428
234.	FEED HEATING SYSTEM	10,242,655	383300 MH	5,286,546	617,205	16,146,406
235.	OTHER TURBINE PLANT EQUIP.	7,835,739	540763 MH	7,453,921	933,020	16,222,680
236.	INSTRUMENTATION + CONTROL	1,250,254	38507 MH	490,702	48,916	1,789,872
237.	TURBINE PLANT MISC ITEMS		113830 MH	1,439,951	2,166,834	3,606,785
23 .	TURBINE PLANT EQUIPMENT	92,726,511	1765723 MH	23,942,209	5,929,779	122,598,499

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1139 MWE PRESSURIZED WATER REACTOR

PLANT CODE 148
COST BASIS 01/78

11/09/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
241.	SWITCHGEAR	5,456,600	61887 MH	806,433	83,689	6,346,722
242.	STATION SERVICE EQUIPMENT	8,886,663	96022 MH	1,244,406	226,816	10,357,885
243.	SWITCHBOARDS	493,000	10371 MH	134,864	65,684	693,548
244.	PROTECTIVE EQUIPMENT		76040 MH	975,836	481,000	1,456,836
245.	ELECT.STRUC +WIRING CONTNR		560383 MH	7,153,112	2,122,615	9,275,727
246.	POWER & CONTROL WIRING	1,106,330	638603 MH	8,195,315	5,378,800	14,680,445
24 .	ELECTRIC PLANT EQUIPMENT	15,942,593	1443306 MH	18,509,966	8,358,604	42,811,163
251.	TRANSPORTATION & LIFT EQPT	2,124,295	28350 MH	390,259	126,797	2,641,351
252.	AIR,WATER+STEAM SERVICE SY	3,733,668	295487 MH	4,068,391	880,220	8,682,279
253.	COMMUNICATIONS EQUIPMENT	1,741,875	23468 MH	301,170	153,201	2,196,246
254.	FURNISHINGS + FIXTURES	976,103	7645 MH	94,932	18,513	1,089,548
25 .	MISCELLANEOUS PLANT EQUIPT	8,575,941	354950 MH	4,854,752	1,178,731	14,609,424
261.	STRUCTURES	105,352	108872 MH	1,343,141	862,292	2,310,785
262.	MECHANICAL EQUIPMENT	14,641,666	261186 MH	3,503,169	552,087	18,696,922
26 .	MAIN COND HEAT REJECT SYS	14,747,018	370058 MH	4,846,310	1,414,379	21,007,707
2 .	TOTAL DIRECT COSTS	247,391,630	11129701 MH	145,132,119	73,543,532	466,067,281

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
911.	TEMPORARY CONSTRUCTION FAC		1620000 MH	17,430,000	8,710,000	26,140,000
912.	CONSTRUCTION TOOLS & EQUIP		250000 MH	3,250,000	20,030,000	23,280,000
913.	PAYROLL INSURANCE & TAXES	24,100,000				24,100,000
914.	PERMITS,INS. & LOCAL TAXES				660,000	660,000
915.	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	24,100,000	1870000 MH	20,680,000	29,400,000	74,180,000
921.	HOME OFFICE SERVICES	86,245,000				86,245,000
922.	HOME OFFICE Q/A	3,745,000				3,745,000
923.	HOME OFFICE CONSTRCTN MGMT	1,335,000				1,335,000
92 .	HOME OFFICE ENGRG.&SERVICE	91,325,000				91,325,000
931.	FIELD OFFICE EXPENSES				3,300,000	3,300,000
932.	FIELD JOB SUPERVISION	20,655,000				20,655,000
933.	FIELD QA/QC	3,135,000				3,135,000
934.	PLANT STARTUP & TEST	3,025,000				3,025,000
93 .	FIELD OFFICE ENGRG&SERVICE	26,815,000			3,300,000	30,115,000
9 .	TOTAL INDIRECT COSTS	142,240,000	1870000 MH	20,680,000	32,700,000	195,620,000
	TOTAL BASE COST	389,631,630	12999701 MH	165,812,119	106,243,532	661,687,281

Table 5-7

1162 MWe Pressurized Heavy Water Reactor NPGS

Capital Cost Estimate

PLANT CODE 160
COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1162 MWE PRESSURIZED HEAVY WATER REACTOR

11/09/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
20 .	LAND + LAND RIGHTS				2,240,000	2,240,000
21 .	STRUCTURES + IMPROVEMENTS	7,430,748	5632418 MH	69,952,154	50,713,781	128,096,683
22 .	REACTOR PLANT EQUIPMENT	150,614,697	2478656 MH	34,284,839	9,229,599	194,129,135
23 .	TURBINE PLANT EQUIPMENT	95,528,675	1875054 MH	25,469,149	5,610,189	126,608,013
24 .	ELECTRIC PLANT EQUIPMENT	16,327,883	1587363 MH	20,343,419	9,416,414	46,087,716
25 .	MISCELLANEOUS PLANT EQUIPT	10,043,681	403065 MH	5,427,808	874,068	16,345,557
26 .	MAIN COND HEAT REJECT SYS	20,269,682	378134 MH	4,953,293	1,416,618	26,639,593
2 .	TOTAL DIRECT COSTS	300,215,366	12354690 MH	160,430,662	79,500,669	540,146,697
91 .	CONSTRUCTION SERVICES	26,500,000	2020000 MH	22,340,000	31,940,000	80,780,000
92 .	HOME OFFICE ENGRG.&SERVICE	97,800,000				97,800,000
93 .	FIELD OFFICE ENGRG&SERVICE	28,775,000			3,560,000	32,335,000
9 .	TOTAL INDIRECT COSTS	153,075,000	2020000 MH	22,340,000	35,500,000	210,915,000
	TOTAL BASE COST	453,290,366	14374690 MH	182,770,662	115,000,669	751,061,697

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1162 MWE PRESSURIZED HEAVY WATER REACTOR

PLANT CODE 160
COST BASIS 01/78

11/09/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
20 .	LAND + LAND RIGHTS				2,240,000	2,240,000
211.	YARDWORK	185,114	439810 MH	5,021,117	4,714,207	9,920,438
212.	REACTOR CONTAINMENT BLDG	3,817,248	2571251 MH	33,389,792	21,894,273	59,101,313
213.	TURBINE ROOM + HEATER BAY	542,988	410913 MH	5,369,662	7,729,266	13,641,916
214.	SECURITY BUILDING	35,968	33233 MH	420,904	268,173	725,045
215.	RX SERV.& F.H. BUILDING	750,000	693156 MH	7,583,794	4,013,600	12,347,394
216.	D2O UPGRADING TOWER STRUCT	90,000	75658 MH	859,269	930,928	1,880,197
218A.	CONTROL RM/D-G BUILDING	1,296,740	688301 MH	8,427,291	3,389,757	13,113,788
218B.	ADMINISTRATION+WAREHOUSE	564,281	190829 MH	2,483,681	2,028,397	5,076,359
218D.	FIRE PUMP HOUSE,INC FNDTNS	18,557	10890 MH	137,269	86,823	242,649
218E.	EMERG. FEEDWATER PUMP BLDG	23,521	130741 MH	1,573,663	553,170	2,150,354
218J.	PENETRATIONS BUILDING	78,786	141895 MH	1,736,559	1,118,788	2,934,133
218K.	PIPE TUNNELS		16820 MH	201,723	89,379	291,102
218S.	HOLDING POND		6992 MH	82,628	35,795	118,423
218T.	ULTIMATE HEAT SINK STRUCT	27,545	211411 MH	2,547,741	3,814,356	6,389,642
218V.	CONTR RM EMG AIR INTK STR		10518 MH	117,061	46,869	163,930
21 .	STRUCTURES + IMPROVEMENTS	7,430,748	5632418 MH	69,952,154	50,713,781	128,096,683

PLANT CODE 160
COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1162 MWE PRESSURIZED HEAVY WATER REACTOR

11/09/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
220A.	NUCLEAR STEAM SUPPLY(NSSS)	113,794,500				113,794,500
220B.	NSSS OPTIONS					
221.	REACTOR EQUIPMENT	924,352	205320 MH	2,892,555	3,027,064	6,843,971
222A.	MAIN HEAT XFER XPORT SYS.	6,835,514	970275 MH	13,481,319	1,741,362	22,058,195
222B.	MODERATOR CIRCUIT	250,083	28824 MH	399,233	80,241	729,557
223.	SAFEGUARDS SYSTEM	2,206,172	203101 MH	2,800,668	375,429	5,382,269
224.	RADWASTE PROCESSING	4,804,146	116059 MH	1,610,194	568,648	6,982,988
225.	FUEL HANDLING + STORAGE	2,316,650	95697 MH	1,331,484	106,356	3,754,490
226.	OTHER REACTOR PLANT EQUIP	10,342,681	659273 MH	9,142,013	1,142,449	20,627,143
227.	RX INSTRUMENTATION+CONTROL	7,519,099	52444 MH	668,512	56,271	8,243,882
228.	REACTOR PLANT MISC ITEMS	1,621,500	147663 MH	1,958,861	2,131,779	5,712,140
22 .	REACTOR PLANT EQUIPMENT	150,614,697	2478656 MH	34,284,839	9,229,599	194,129,135
231.	TURBINE GENERATOR	65,131,243	429842 MH	5,669,286	1,279,356	72,079,885
233.	CONDENSING SYSTEMS	12,951,110	320666 MH	4,453,645	668,515	18,073,270
234.	FEED HEATING SYSTEM	8,314,323	424900 MH	5,869,166	643,149	14,826,638
235.	OTHER TURBINE PLANT EQUIP.	8,012,495	539674 MH	7,441,145	755,058	16,208,698
236.	INSTRUMENTATION + CONTROL	1,119,504	38492 MH	490,512	41,897	1,651,913
237.	TURBINE PLANT MISC ITEMS		121480 MH	1,545,395	2,222,214	3,767,609
23 .	TURBINE PLANT EQUIPMENT	95,528,675	1875054 MH	25,469,149	5,610,189	126,608,013

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
241.	SWITCHGEAR	5,676,100	67929 MH	885,165	91,562	6,652,827
242.	STATION SERVICE EQUIPMENT	9,124,333	109811 MH	1,408,250	310,453	10,843,036
243.	SWITCHBOARDS	493,000	10371 MH	134,864	65,684	693,548
244.	PROTECTIVE EQUIPMENT		76040 MH	975,836	481,000	1,456,836
245.	ELECT.STRUC +WIRING CONTNR		613690 MH	7,833,871	2,419,495	10,253,366
246.	POWER & CONTROL WIRING	1,034,450	709522 MH	9,105,433	6,048,220	16,188,103
24 .	ELECTRIC PLANT EQUIPMENT	16,327,883	1587363 MH	20,343,419	9,416,414	46,087,716
251.	TRANSPORTATION & LIFT EQPT	2,124,295	28350 MH	390,259	126,797	2,641,351
252.	AIR,WATER+STEAM SERVICE SY	5,201,408	248570 MH	3,421,882	453,601	9,076,891
253.	COMMUNICATIONS EQUIPMENT	1,741,875	118500 MH	1,520,735	275,157	3,537,767
254.	FURNISHINGS + FIXTURES	976,103	7645 MH	94,932	18,513	1,089,548
25 .	MISCELLANEOUS PLANT EQUIPT	10,043,681	403065 MH	5,427,808	874,068	16,345,557
261.	STRUCTURES	105,352	110888 MH	1,366,794	859,867	2,332,013
262.	MECHANICAL EQUIPMENT	20,164,330	267246 MH	3,586,499	556,751	24,307,580
26 .	MAIN COND HEAT REJECT SYS	20,269,682	378134 MH	4,953,293	1,416,618	26,639,593
2 .	TOTAL DIRECT COSTS	300,215,366	12354690 MH	160,430,662	79,500,669	540,146,697

PLANT CODE 160
COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1162 MWE PRESSURIZED HEAVY WATER REACTOR

11/09/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
911.	TEMPORARY CONSTRUCTION FAC		1750000 MH	18,830,000	9,410,000	28,240,000
912.	CONSTRUCTION TOOLS & EQUIP		270000 MH	3,510,000	21,780,000	25,290,000
913.	PAYROLL INSURANCE & TAXES	26,500,000				26,500,000
914.	PERMITS,INS. & LOCAL TAXES				750,000	750,000
915.	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	26,500,000	2020000 MH	22,340,000	31,940,000	80,780,000
921.	HOME OFFICE SERVICES	92,450,000				92,450,000
922.	HOME OFFICE Q/A	4,015,000				4,015,000
923.	HOME OFFICE CONSTRCTN MGMT	1,335,000				1,335,000
92 .	HOME OFFICE ENGRG.&SERVICE	97,800,000				97,800,000
931.	FIELD OFFICE EXPENSES				3,560,000	3,560,000
932.	FIELD JOB SUPERVISION	22,230,000				22,230,000
933.	FIELD QA/QC	3,390,000				3,390,000
934.	PLANT STARTUP & TEST	3,155,000				3,155,000
93 .	FIELD OFFICE ENGRG&SERVICE	28,775,000			3,560,000	32,335,000
9 .	TOTAL INDIRECT COSTS	153,075,000	2020000 MH	22,340,000	35,500,000	210,915,000
	TOTAL BASE COST	453,290,366	14374690 MH	182,770,662	115,000,669	751,061,697

Table 5-8

917 MWe Gas Cooled Fast Reactor NPGS

Capital Cost Estimate

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                                        UNITED ENGINEERS & CONSTRUCTORS INC.                                       SUMMARY PAGE    1
PLANT CODE      COST BASIS              ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
   350            01/78                 917 MWE GAS COOLED FAST REACTOR                                                11/13/79

                                               FACTORY           SITE            SITE             SITE             TOTAL
ACCT NO        ACCOUNT DESCRIPTION          EQUIP. COSTS     LABOR HOURS      LABOR COST     MATERIAL COST         COSTS
********** *************************     *************   ************   *************   *************   *************

20 .        LAND AND LAND RIGHTS                                                               2,240,000        2,240,000

21 .        STRUCTURES & IMPROVEMENTS           4,649,787     4887608 MH      61,639,232      45,093,178      111,382,197

22 .        REACTOR PLANT EQUIPMENT           178,191,148     1819641 MH      25,049,787       3,833,173      207,074,108

23 .        TURBINE PLANT EQUIPMENT            69,853,919     1119158 MH      15,040,287       3,481,089       88,375,295

24 .        ELECTRIC PLANT EQUIP               13,245,330     1144618 MH      14,658,992       7,392,172       35,296,494

25 .        MISC. PLANT EQUIP                   7,248,655      286167 MH       3,910,733         630,279       11,789,667

26 .        MAIN COND HEAT REJECT SYS           8,650,933      265404 MH       3,369,060       1,889,044       13,909,037


2  .        TOTAL DIRECT COSTS                281,839,772     9522596 MH     123,668,091      64,558,935      470,066,798


91 .        CONSTRUCTION SERVICES              17,932,000     1815000 MH      20,090,000      28,350,000       66,372,000

92 .        HOME OFFICE ENGRG.&SERVICE        114,430,000                                                      114,430,000

93 .        FIELD OFFICE ENGRG&SERVICE         27,680,000                                      3,205,000       30,885,000


9  .        TOTAL INDIRECT COSTS              160,042,000     1815000 MH      20,090,000      31,555,000      211,687,000



            TOTAL BASE COST                   441,881,772    11337596 MH     143,758,091      96,113,935      681,753,798
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PLANT CODE 350 COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
917 MWE GAS COOLED FAST REACTOR

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
20 .	LAND AND LAND RIGHTS				2,240,000	2,240,000
211.	YARDWORK	241,120	402479 MH	4,758,815	4,613,441	9,613,376
212.	REACTOR CONTAINMENT BLDG	899,462	1896052 MH	24,523,252	17,465,443	42,888,157
213.	TURBINE ROOM + HEATER BAY	699,225	388253 MH	5,059,636	6,544,656	12,303,517
214.	SECURITY BUILDING	35,968	33183 MH	420,076	272,683	728,727
215.	REACT SERV & FUEL STORAGE	762,339	470306 MH	5,807,599	3,730,939	10,300,877
216.	RADWASTE BUILDING		151640 MH	1,914,000	1,086,000	3,000,000
218A.	CONTROL RM/D-G BUILDING	1,361,709	632088 MH	7,738,163	3,036,924	12,136,796
218B.	ADMIN + SERV BLDG	559,141	166759 MH	2,166,826	1,500,403	4,226,370
218D.	FIRE PUMP HOUSE	18,642	10883 MH	137,242	86,640	242,524
218E.	HELIUM STORAGE AREA		29715 MH	346,494	101,967	448,461
218H.	DIES CLG + FL OIL STG BLDG	11,448	47079 MH	576,762	318,682	906,892
218I.	ACCESS BUILDING		25324 MH	326,857	424,174	751,031
218J.	PIPING PENETRATION BUILDNG		204298 MH	2,516,232	1,250,929	3,767,161
218K.	REACTOR AUX. BUILDING		84868 MH	1,147,379	2,445,946	3,593,325
218S.	HOLDING POND		11393 MH	135,981	59,592	195,573
218T.	ULTIMATE HEAT SINK STRUCT	40,733	270401 MH	3,306,410	1,740,383	5,087,526
218U.	ULT. HEAT SINK TUNNEL		54903 MH	668,066	376,959	1,045,025
218V.	CTL RM EMG AIR IN STR	20,000	7984 MH	89,442	37,417	146,859
21 .	STRUCTURES & IMPROVEMENTS	4,649,787	4887608 MH	61,639,232	45,093,178	111,382,197

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
917 MWE GAS COOLED FAST REACTOR

PLANT CODE 350
COST BASIS 01/78

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
220A.	NUCLEAR STEAM SUPPLY(NSSS)	161,490,000				161,490,000
220B.	NSSS OPTIONS					
221.	REACTOR EQUIPMENT	15,094	818267 MH	11,341,575	961,662	12,318,331
222.	MAIN HEAT TRANS SYS.	194,687	120163 MH	1,720,571	203,338	2,118,596
223.	SAFEGUARDS COOL. SYS.	4,071,045	241392 MH	3,328,820	381,240	7,781,105
224.	RAD WASTE PROCESSING	787,230	65138 MH	898,268	167,235	1,852,733
225.	NUCLEAR FUEL HANDLING + ST	1,407,639	81640 MH	1,118,881	131,099	2,657,619
226.	OTHER REACTOR PLANT EQUIP	8,873,453	327156 MH	4,505,353	1,716,467	15,095,273
227.	INSTRUMENTATION + CONTROL	1,352,000	66805 MH	851,305	15,328	2,218,633
228.	REACTOR PLANT MISC ITEMS		99080 MH	1,285,014	256,804	1,541,818
22 .	REACTOR PLANT EQUIPMENT	178,191,148	1819641 MH	25,049,787	3,833,173	207,074,108
231.	TURBINE GENERATOR	43,222,775	301751 MH	3,930,944	1,169,462	48,323,181
233.	CONDENSING SYS.	7,412,459	206102 MH	2,848,050	754,247	11,014,756
234.	FEED HEAT. SYS.	8,429,420	169993 MH	2,335,604	248,215	11,013,239
235.	OTHER TURB PLANT EQUIP	9,851,465	331612 MH	4,575,537	635,601	15,062,603
236.	INSTRUMENTATION + CONTROL	937,800	49317 MH	628,452	5,045	1,571,297
237.	TURBINE PLANT MISC ITEMS		60383 MH	721,700	668,519	1,390,219
23 .	TURBINE PLANT EQUIPMENT	69,853,919	1119158 MH	15,040,287	3,481,089	88,375,295

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
917 MWE GAS COOLED FAST REACTOR

PLANT CODE 350
COST BASIS 01/78

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
241.	SWITCHGEAR	4,650,880	56162 MH	731,836	76,129	5,458,845
242.	STATION SERVICE EQUIP	7,680,750	75184 MH	973,100	166,401	8,820,251
243.	SWITCHBOARDS	479,300	12290 MH	159,275	14,324	652,899
244.	PROTECTIVE EQUIP		80286 MH	1,030,323	473,000	1,503,323
245.	ELEC STRUC + WIRING CNTNRS		458468 MH	5,832,592	1,737,620	7,570,212
246.	POWER & CONTROL WIRING	434,400	462228 MH	5,931,866	4,924,698	11,290,964
24 .	ELECTRIC PLANT EQUIP	13,245,330	1144618 MH	14,658,992	7,392,172	35,296,494
251.	TRANSPORTATION+LIFT EQUIP	2,041,582	17260 MH	237,596	23,760	2,302,938
252.	AIR WTR+STEAM SERV SYS	3,089,307	237580 MH	3,276,434	546,896	6,912,637
253.	COMMUNICATIONS EQUIP	1,161,237	23400 MH	299,629	25,248	1,486,114
254.	FURNISHINGS + FIXTURES	956,529	7927 MH	97,074	34,375	1,087,978
25 .	MISC. PLANT EQUIP	7,248,655	286167 MH	3,910,733	630,279	11,789,667
261.	STRUCTURES	57,618	113643 MH	1,396,984	988,458	2,443,060
262.	MECHANICAL EQUIPMENT	8,593,315	151761 MH	1,972,076	900,586	11,465,977
26 .	MAIN COND HEAT REJECT SYS	8,650,933	265404 MH	3,369,060	1,889,044	13,909,037
2 .	TOTAL DIRECT COSTS	281,839,772	9522596 MH	123,668,091	64,558,935	470,066,798

PLANT CODE 350 COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
917 MWE GAS COOLED FAST REACTOR

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
**********	*************************	*************	************	*************	*************	**************
911.	TEMPORARY CONSTRUCTION FAC		1570000 MH	16,905,000	8,450,000	25,355,000
912.	CONSTRUCTION TOOLS & EQUIP		245000 MH	3,185,000	19,200,000	22,385,000
913.	PAYROLL INSURANCE & TAXES	17,932,000				17,932,000
914.	PERMITS,INS. & LOCAL TAXES				700,000	700,000
915.	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	17,932,000	1815000 MH	20,090,000	28,350,000	66,372,000
921.	HOME OFFICE SERVICES	107,790,000				107,790,000
922.	HOME OFFICE Q/A	5,305,000				5,305,000
923.	HOME OFFICE CONSTRCTN MGMT	1,335,000				1,335,000
92 .	HOME OFFICE ENGRG.&SERVICE	114,430,000				114,430,000
931.	FIELD OFFICE EXPENSES				3,205,000	3,205,000
932.	FIELD JOB SUPERVISION	20,030,000				20,030,000
933.	FIELD QA/QC	3,890,000				3,890,000
934.	PLANT STARTUP & TEST	3,760,000				3,760,000
93 .	FIELD OFFICE ENGRG&SERVICE	27,680,000			3,205,000	30,885,000
9 .	TOTAL INDIRECT COSTS	160,042,000	1815000 MH	20,090,000	31,555,000	211,687,000
	TOTAL BASE COST	441,881,772	11337596 MH	143,758,091	96,113,935	681,753,798

Table 5-9

1390 MWe Liquid Metal Fast Breeder Reactor NPGS

Capital Cost Estimate

PLANT CODE 401

COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1390 MWE LIQUID METAL FAST BREEDER REACTOR

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
20 .	LAND AND LAND RIGHTS	2,240,000				2,240,000
21 .	STRUCTURES + IMPROVEMENTS	146,712,671				146,712,671
22 .	REACTOR PLANT EQUIPMENT	370,414,955				370,414,955
23 .	TURBINE PLANT EQUIPMENT	122,080,000				122,080,000
24 .	ELECTRIC PLANT EQUIPMENT	56,390,250				56,390,250
25 .	MISCELLANEOUS PLANT EQUIPT	17,319,514				17,319,514
26 .	MAIN COND HEAT REJECT SYS	21,421,810				21,421,810
2 .	TOTAL DIRECT COSTS	736,579,200				736,579,200
91 .	CONSTRUCTION SERVICES	30,560,000	1930000 MH	38,790,000	21,650,000	91,000,000
92 .	HOME OFFICE ENGRG.&SERVICE	136,300,000				136,300,000
93 .	FIELD OFFICE ENGRG&SERVICE	33,725,000			3,930,000	37,655,000
9 .	TOTAL INDIRECT COSTS	200,585,000	1930000 MH	38,790,000	25,580,000	264,955,000
	TOTAL BASE COST	937,164,200	1930000 MH	38,790,000	25,580,000	1,001,534,200

PLANT CODE 401 COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1390 MWE LIQUID METAL FAST BREEDER REACTOR

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
20 .	LAND AND LAND RIGHTS	2,240,000				2,240,000
211.	YARDWORK	11,743,756				11,743,756
212.	REACTOR CONTAINMENT BLDG	65,232,000				65,232,000
213.	TURBINE ROOM + HEATER BAY	10,411,000				10,411,000
214.	SECURITY BUILDING	806,966				806,966
215.	REACTOR SERV BLDG+ TUNNELS	8,461,453				8,461,453
217.	FUEL HANDLING BLDG					
218A.	CONTROL RM/ D-G BUILDING	13,750,000				13,750,000
218B.	ADMINISTRATION+SERVICE BLG	1,540,000				1,540,000
218D.	FIRE PUMP HOUSE,INC FNDTNS	243,000				243,000
218E.	STEAM GENERATOR BLDG	12,190,000				12,190,000
218F.	MANWAY TUNNELS (RCA TUNLS)	575,000				575,000
218G.	ELEC. TUNNELS					
218H.	NON-ESSEN. SWGR BLDG.	484,760				484,760
218I.	AUXILIARY BLDGS	10,430,000				10,430,000
218J.	MN STEAM + FW PIPE ENC.					
218K.	PIPE TUNNELS	150,000				150,000
218N.	MAINT. BLDG + AUX BOILER	5,391,000				5,391,000
218P.	CONTAIN EQ HATCH MSLE SHLD					
218S.	HOLDING POND	158,736				158,736
218T.	AUX HEAT TRANS SYS BAYS	4,980,000				4,980,000
218V.	CONTR RM EMG AIR INTK STR	165,000				165,000
21 .	STRUCTURES + IMPROVEMENTS	146,712,671				146,712,671

PLANT CODE 401 COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1390 MWE LIQUID METAL FAST BREEDER REACTOR

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
220A.	NUCLEAR STEAM SUPPLY(NSSS)	282,904,000				282,904,000
220B.	NSSS OPTIONS					
221.	REACTOR EQUIPMENT	7,104,325				7,104,325
222.	MAIN HEAT XFER XPORT SYS.	38,398,866				38,398,866
223.	SAFEGUARDS SYSTEM	1,633,333				1,633,333
224.	RADWASTE PROCESSING	4,081,258				4,081,258
225.	FUEL HANDLING + STORAGE	4,290,672				4,290,672
226.	OTHER REACTOR PLANT EQUIP	17,100,955				17,100,955
227.	RX INSTRUMENTATION+CONTROL	2,470,491				2,470,491
228.	REACTOR PLANT MISC ITEMS	12,431,055				12,431,055
22 .	REACTOR PLANT EQUIPMENT	370,414,955				370,414,955
231.	TURBINE GENERATOR	67,490,000				67,490,000
233.	CONDENSING SYSTEMS	13,760,000				13,760,000
234.	FEED HEATING SYSTEM	22,350,000				22,350,000
235.	OTHER TURBINE PLANT EQUIP.	13,760,000				13,760,000
236.	INSTRUMENTATION + CONTROL	1,200,000				1,200,000
237.	TURBINE PLANT MISC ITEMS	3,520,000				3,520,000
23 .	TURBINE PLANT EQUIPMENT	122,080,000				122,080,000

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1390 MWE LIQUID METAL FAST BREEDER REACTOR

PLANT CODE 401
COST BASIS 01/78

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
241.	SWITCHGEAR					
242.	STATION SERVICE EQUIPMENT					
243.	SWITCHBOARDS					
244.	PROTECTIVE EQUIPMENT					
245.	ELECT.STRUC +WIRING CONTNR					
246.	POWER & CONTROL WIRING					
24 .	ELECTRIC PLANT EQUIPMENT	56,390,250				56,390,250
251.	TRANSPORTATION & LIFT EQPT	2,939,412				2,939,412
252.	SERVICE SYSTEMS	11,793,190				11,793,190
253.	COMMUNICATIONS EQUIPMENT	1,478,760				1,478,760
254.	FURNISHINGS + FIXTURES	1,108,152				1,108,152
25 .	MISCELLANEOUS PLANT EQUIPT	17,319,514				17,319,514
261.	STRUCTURES					
262.	MECHANICAL EQUIPMENT					
26 .	MAIN COND HEAT REJECT SYS	21,421,810				21,421,810
2 .	TOTAL DIRECT COSTS	736,579,200				736,579,200

PLANT CODE 401
COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1390 MWE LIQUID METAL FAST BREEDER REACTOR

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
911.	TEMPORARY CONSTRUCTION FAC		1630000 MH	20,790,000	10,360,000	31,150,000
912.	CONSTRUCTION TOOLS & EQUIP		300000 MH	16,990,000	11,290,000	28,280,000
913.	PAYROLL INSURANCE & TAXES	30,560,000				30,560,000
914.	PERMITS,INS. & LOCAL TAXES			1,010,000		1,010,000
915.	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	30,560,000	1930000 MH	38,790,000	21,650,000	91,000,000
921.	HOME OFFICE SERVICES	129,345,000				129,345,000
922.	HOME OFFICE Q/A	5,620,000				5,620,000
923.	HOME OFFICE CONSTRCTN MGMT	1,335,000				1,335,000
92 .	HOME OFFICE ENGRG.&SERVICE	136,300,000				136,300,000
931.	FIELD OFFICE EXPENSES				3,930,000	3,930,000
932.	FIELD JOB SUPERVISION	24,590,000				24,590,000
933.	FIELD QA/QC	4,660,000				4,660,000
934.	PLANT STARTUP & TEST	4,475,000				4,475,000
93 .	FIELD OFFICE ENGRG&SERVICE	33,725,000			3,930,000	37,655,000
9 .	TOTAL INDIRECT COSTS	200,585,000	1930000 MH	38,790,000	25,580,000	264,955,000
	TOTAL BASE COST	937,164,200	1930000 MH	38,790,000	25,580,000	1,001,534,200

Table 5-10

1232 MWe High Sulfur Coal FPGS

Capital Cost Estimate

[redacted]

PLANT CODE 610   COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1232 MWE HIGH SULFUR COAL

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
20 .	LAND AND LAND RIGHTS				2,240,000	2,240,000
21 .	STRUCTURES + IMPROVEMENTS	2,049,055	1718487 MH	21,746,876	33,340,126	57,136,057
22 .	BOILER PLANT EQUIPMENT	117,258,312	3591066 MH	48,388,708	18,211,897	183,858,917
23 .	TURBINE PLANT EQUIPMENT	97,232,421	1838159 MH	25,020,360	5,696,298	127,949,079
24 .	ELECTRIC PLANT EQUIPMENT	10,938,620	1245315 MH	15,969,391	9,263,483	36,171,494
25 .	MISCELLANEOUS PLANT EQUIPT	6,256,902	258934 MH	3,527,595	869,267	10,653,764
26 .	MAIN COND HEAT REJECT SYS	10,802,776	268423 MH	3,503,926	1,158,081	15,464,783
2 .	TOTAL DIRECT COSTS	244,538,086	8920384 MH	118,156,856	70,779,152	433,474,094
91 .	CONSTRUCTION SERVICES	19,740,000	1270000 MH	14,090,000	20,800,000	54,630,000
92 .	HOME OFFICE ENGRG.&SERVICE	18,790,000				18,790,000
93 .	FIELD OFFICE ENGRG&SERVICE	14,720,000			1,120,000	15,840,000
9 .	TOTAL INDIRECT COSTS	53,250,000	1270000 MH	14,090,000	21,920,000	89,260,000
	TOTAL BASE COST	297,788,086	10190384 MH	132,246,856	92,699,152	522,734,094

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1232 MWE HIGH SULFUR COAL

PLANT CODE 610
COST BASIS 01/78

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
20 .	LAND AND LAND RIGHTS				2,240,000	2,240,000
211.	YARDWORK	636,588	269124 MH	2,927,823	3,049,796	6,614,207
212.	STEAM GENERATOR BUILDING	503,006	622776 MH	8,148,673	16,862,622	25,514,301
213.	TURBINE,HEATER,CONTROL BLD	303,414	292753 MH	3,812,932	6,300,095	10,416,441
218B.	ADMINISTRATION+SERVICE BLD	238,129	67996 MH	883,183	924,196	2,045,508
218D.	FIRE PUMPHOUSE					
218I.	ELECTRICAL SWITCHGR BLDGS	24,028	7210 MH	93,453	50,265	167,746
218M.	COAL CAR THAW SHED		2319 MH	28,393	13,868	42,261
218N.	ROTARY CAR DUMP BLDG+TUNNL	3,917	40006 MH	500,245	405,098	909,260
218O.	COAL BREAKER HOUSE	59,465	20747 MH	279,019	385,476	723,960
218P.	COAL CRUSHER HOUSE	86,742	16000 MH	213,938	224,927	525,607
218Q.	BOILER HOUSE TRANSFR TOWER	3,012	5987 MH	82,699	148,449	234,160
218R.	ROTARY PLOW MAINTNCE SHED	6,789	97642 MH	1,192,187	852,758	2,051,734
218T.	LOCOMOTIVE REPAIR GARAGE	13,005	4912 MH	64,616	72,578	150,199
218U.	MATERIAL HANDL+SERVICE BLD	15,438	10750 MH	141,819	154,821	312,078
218V.	WASTE WATER TREATMENT BLDG	5,522	11624 MH	146,905	103,434	255,861
218W.	MISC COAL HANDLING STRUCT	150,000	75183 MH	912,628	1,157,003	2,219,631
219.	STACK STRUCTURE		173458 MH	2,318,363	2,634,740	4,953,103
21 .	STRUCTURES + IMPROVEMENTS	2,049,055	1718487 MH	21,746,876	33,340,126	57,136,057

PLANT CODE 610
COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1232 MWE HIGH SULFUR COAL

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
220A.	FOSSIL STEAM SUPPLY SYSTEM	61,854,925	1128000 MH	15,093,768	1,509,377	78,458,070
221.	STEAM GENERATING SYSTEM	1,347,814	37651 MH	519,811	62,949	1,930,574
222.	DRAFT SYSTEM	13,873,820	412685 MH	5,800,032	1,861,185	21,535,037
223.	ASH + DUST HANDLING SYSTEM	5,071,870	115826 MH	1,588,848	233,926	6,894,644
224.	FUEL HANDLING SYSTEMS	7,513,565	144286 MH	2,016,209	630,218	10,159,992
225.	FLUE GAS DESULFUR STRUCT	95,972	72540 MH	943,215	1,057,306	2,096,493
226.	DESULFURIZATION EQUIPMENT	24,669,698	1480260 MH	19,901,340	11,110,300	55,681,338
227.	INSTRUMENTATION + CONTROL	2,644,328	53628 MH	683,386	36,203	3,363,917
228.	BOILER PLANT MISC ITEMS	186,320	146190 MH	1,842,099	1,710,433	3,738,852
22 .	BOILER PLANT EQUIPMENT	117,258,312	3591066 MH	48,388,708	18,211,897	183,858,917
231.	TURBINE GENERATOR	60,117,532	347571 MH	4,552,781	1,700,629	66,370,942
233.	CONDENSING SYSTEMS	8,708,805	164659 MH	2,318,240	340,851	11,367,896
234.	FEED HEATING SYSTEM	15,511,365	312966 MH	4,319,325	433,028	20,263,718
235.	OTHER TURBINE PLANT EQUIP.	12,789,759	920340 MH	12,685,131	1,291,305	26,766,195
236.	INSTRUMENTATION + CONTROL	104,960	823 MH	10,488	524	115,972
237.	TURBINE PLANT MISC ITEMS		91800 MH	1,134,395	1,929,961	3,064,356
23 .	TURBINE PLANT EQUIPMENT	97,232,421	1838159 MH	25,020,360	5,696,298	127,949,079

PLANT CODE 610 COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1232 MWE HIGH SULFUR COAL

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
**********	**************************	*************	************	*************	*************	**************
241.	SWITCHGEAR	5,787,600	67230 MH	876,058	93,754	6,757,412
242.	STATION SERVICE EQUIPMENT	3,932,000	60010 MH	773,798	149,764	4,855,562
243.	SWITCHBOARDS	555,000	10530 MH	136,956	66,028	757,984
244.	PROTECTIVE EQUIPMENT		85400 MH	1,100,802	674,325	1,775,127
245.	ELECT.STRUC +WIRING CONTNR		572875 MH	7,316,204	2,601,903	9,918,107
246.	POWER & CONTROL WIRING	664,020	449270 MH	5,765,573	5,677,709	12,107,302
24 .	ELECTRIC PLANT EQUIPMENT	10,938,620	1245315 MH	15,969,391	9,263,483	36,171,494
251.	TRANSPORTATION & LIFT EQPT	1,384,114	8125 MH	111,160	98,886	1,594,160
252.	AIR,WATER+STEAM SERVICE SY	3,407,285	182401 MH	2,510,860	316,223	6,234,368
253.	COMMUNICATIONS EQUIPMENT	100,000	25000 MH	320,830	155,167	575,997
254.	FURNISHINGS + FIXTURES	721,801	6717 MH	83,031	17,323	822,155
255.	WASTE WATER TREATMENT EQPT	643,702	36691 MH	501,714	281,668	1,427,084
25 .	MISCELLANEOUS PLANT EQUIPT	6,256,902	258934 MH	3,527,595	869,267	10,653,764
261.	STRUCTURES	98,026	80751 MH	996,805	741,885	1,836,716
262.	MECHANICAL EQUIPMENT	10,704,750	187672 MH	2,507,121	416,196	13,628,067
26 .	MAIN COND HEAT REJECT SYS	10,802,776	268423 MH	3,503,926	1,158,081	15,464,783
2 .	TOTAL DIRECT COSTS	244,538,086	8920384 MH	118,156,856	70,779,152	433,474,094

PLANT CODE 610 COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1232 MWE HIGH SULFUR COAL

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
911.	TEMPORARY CONSTRUCTION FAC		1090000 MH	11,750,000	5,880,000	17,630,000
912.	CONSTRUCTION TOOLS & EQUIP		180000 MH	2,340,000	14,920,000	17,260,000
913.	PAYROLL INSURANCE & TAXES	19,215,000				19,215,000
914.	PERMITS,INS. & LOCAL TAXES	525,000				525,000
915.	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	19,740,000	1270000 MH	14,090,000	20,800,000	54,630,000
921.	HOME OFFICE SERVICES	17,720,000				17,720,000
922.	HOME OFFICE Q/A					
923.	HOME OFFICE CONSTRCTN MGMT	1,070,000				1,070,000
92 .	HOME OFFICE ENGRG.&SERVICE	18,790,000				18,790,000
931.	FIELD OFFICE EXPENSES				1,120,000	1,120,000
932.	FIELD JOB SUPERVISION	13,910,000				13,910,000
933.	FIELD QA/QC	250,000				250,000
934.	PLANT STARTUP & TEST	560,000				560,000
93 .	FIELD OFFICE ENGRG&SERVICE	14,720,000			1,120,000	15,840,000
9 .	TOTAL INDIRECT COSTS	53,250,000	1270000 MH	14,090,000	21,920,000	89,260,000
	TOTAL BASE COST	297,788,086	10190384 MH	132,246,856	92,699,152	522,734,094

Table 5-11

795 MWe High Sulfur Coal FPGS

Capital Cost Estimate

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                                              UNITED ENGINEERS & CONSTRUCTORS INC.                                  SUMMARY PAGE    1
 PLANT CODE      COST BASIS                   ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
    640            01/78                      795 MWE HIGH SULFUR COAL                                                  11/13/79

                                                  FACTORY            SITE            SITE           SITE             TOTAL
ACCT NO        ACCOUNT DESCRIPTION              EQUIP. COSTS     LABOR HOURS      LABOR COST    MATERIAL COST        COSTS
********* *************************            *************    ************    *************   *************    *************

20 .      LAND AND LAND RIGHTS                                                                     2,240,000         2,240,000

21 .      STRUCTURES + IMPROVEMENTS              1,695,734     1423100 MH       17,982,856      26,603,324        46,281,914

22 .      BOILER PLANT EQUIPMENT                84,697,367     2583843 MH       34,719,938      13,012,479       132,429,784

23 .      TURBINE PLANT EQUIPMENT               52,968,778      992078 MH       13,430,639       3,395,564        69,794,981

24 .      ELECTRIC PLANT EQUIPMENT               9,409,880     1082365 MH       13,880,447       8,173,537        31,463,864

25 .      MISCELLANEOUS PLANT EQUIPT             5,680,520      221728 MH        3,014,847         753,144         9,448,511

26 .      MAIN COND HEAT REJECT SYS              8,351,535      217330 MH        2,834,302         956,228        12,142,065


2  .      TOTAL DIRECT COSTS                   162,803,814     6520444 MH       85,863,029      55,134,276       303,801,119


91 .      CONSTRUCTION SERVICES                 13,935,000      965000 MH       10,655,000      14,370,000        38,960,000

92 .      HOME OFFICE ENGRG.&SERVICE            15,835,000                                                        15,835,000

93 .      FIELD OFFICE ENGRG&SERVICE            10,615,000                         800,000                        11,415,000


9  .      TOTAL INDIRECT COSTS                  40,385,000      965000 MH       11,455,000      14,370,000        66,210,000



          TOTAL BASE COST                      203,188,814     7485444 MH       97,318,029      69,504,276       370,011,119
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PLANT CODE 640
COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
795 MWE HIGH SULFUR COAL

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
20 .	LAND AND LAND RIGHTS				2,240,000	2,240,000
211.	YARDWORK	602,588	226642 MH	2,472,448	2,567,508	5,642,544
212.	STEAM GENERATOR BUILDING	410,241	463948 MH	6,057,618	12,224,636	18,692,495
213.	TURBINE,HEATER,CONTROL BLD	249,360	249981 MH	3,254,047	5,302,230	8,805,637
218B.	ADMINISTRATION+SERVICE BLD	218,446	61441 MH	798,040	811,329	1,827,815
218I.	ELECTRICAL SWITCHGR BLDGS	22,220	6649 MH	86,156	45,266	153,642
218M.	COAL CAR THAW SHED		2319 MH	28,393	13,868	42,261
218N.	ROTARY CAR DUMP BLDG+TUNNL	3,917	40006 MH	500,245	405,098	909,260
218O.	COAL BREAKER HOUSE	59,465	20747 MH	279,019	385,476	723,960
218P.	COAL CRUSHER HOUSE	86,742	14925 MH	199,717	203,644	490,103
218Q.	BOILER HOUSE TRANSFR TOWER	2,001	3040 MH	41,584	76,753	120,338
218R.	ROTARY PLOW MAINTNCE SHED	6,789	97642 MH	1,192,187	852,758	2,051,734
218T.	LOCOMOTIVE REPAIR GARAGE	13,005	4912 MH	64,616	72,578	150,199
218U.	MATERIAL HANDL+SERVICE BLD	15,438	10750 MH	141,819	154,821	312,078
218V.	WASTE WATER TREATMENT BLDG	5,522	8841 MH	112,149	82,493	200,164
218W.	MISC COAL HANDLING STRUCT		64740 MH	797,833	1,176,876	1,974,709
219.	STACK STRUCTURE		146517 MH	1,956,985	2,227,990	4,184,975
21 .	STRUCTURES + IMPROVEMENTS	1,695,734	1423100 MH	17,982,856	26,603,324	46,281,914

PLANT CODE 640　COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
795 MWE HIGH SULFUR COAL

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
**********	*************************	*************	************	*************	*************	**************
220A.	FOSSIL STEAM SUPPLY SYSTEM	43,728,960	736455 MH	9,854,504	985,450	54,568,914
221.	STEAM GENERATING SYSTEM	1,054,205	28830 MH	398,094	50,778	1,503,077
222.	DRAFT SYSTEM	8,312,140	268889 MH	3,773,878	1,191,502	13,277,520
223.	ASH + DUST HANDLING SYSTEM	4,316,990	102228 MH	1,398,540	192,045	5,907,575
224.	FUEL HANDLING SYSTEMS	7,117,912	125981 MH	1,750,586	432,416	9,300,914
225.	FLUE GAS DESULFUR STRUCT	68,178	57191 MH	743,411	854,562	1,666,151
226.	DESULFURIZATION EQUIPMENT	17,342,374	1050966 MH	14,117,747	8,036,336	39,496,457
227.	INSTRUMENTATION + CONTROL	2,570,288	81040 MH	1,032,701	71,477	3,674,466
228.	BOILER PLANT MISC ITEMS	186,320	132263 MH	1,650,477	1,197,913	3,034,710
22 .	BOILER PLANT EQUIPMENT	84,697,367	2583843 MH	34,719,938	13,012,479	132,429,784
231.	TURBINE GENERATOR	31,191,793	237233 MH	3,114,738	997,300	35,303,831
233.	CONDENSING SYSTEMS	6,713,688	127632 MH	1,799,891	235,263	8,748,842
234.	FEED HEATING SYSTEM	8,961,325	175518 MH	2,423,265	243,441	11,628,031
235.	OTHER TURBINE PLANT EQUIP.	5,997,012	372962 MH	5,140,516	541,316	11,678,844
236.	INSTRUMENTATION + CONTROL	104,960	823 MH	10,488	524	115,972
237.	TURBINE PLANT MISC ITEMS		77910 MH	941,741	1,377,720	2,319,461
23 .	TURBINE PLANT EQUIPMENT	52,968,778	992078 MH	13,430,639	3,395,564	69,794,981

PLANT CODE 640 COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
795 MWE HIGH SULFUR COAL

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
241.	SWITCHGEAR	5,011,400	57640 MH	751,096	78,183	5,840,679
242.	STATION SERVICE EQUIPMENT	3,414,200	50615 MH	653,492	120,788	4,188,480
243.	SWITCHBOARDS	458,000	9030 MH	117,410	64,073	639,483
244.	PROTECTIVE EQUIPMENT		76400 MH	985,304	625,325	1,610,629
245.	ELECT.STRUC +WIRING CONTNR		502760 MH	6,420,556	2,281,365	8,701,921
246.	POWER & CONTROL WIRING	526,280	385920 MH	4,952,589	5,003,803	10,482,672
24 .	ELECTRIC PLANT EQUIPMENT	9,409,880	1082365 MH	13,880,447	8,173,537	31,463,864
251.	TRANSPORTATION & LIFT EQPT	1,308,438	7200 MH	98,424	97,612	1,504,474
252.	AIR,WATER+STEAM SERVICE SY	2,930,145	154351 MH	2,124,692	272,738	5,327,575
253.	COMMUNICATIONS EQUIPMENT	100,000	25000 MH	320,830	155,167	575,997
254.	FURNISHINGS + FIXTURES	721,801	6717 MH	83,031	17,323	822,155
255.	WASTE WATER TREATMENT EQPT	620,136	28460 MH	387,870	210,304	1,218,310
25 .	MISCELLANEOUS PLANT EQUIPT	5,680,520	221728 MH	3,014,847	753,144	9,448,511
261.	STRUCTURES	85,203	64602 MH	797,672	609,635	1,492,510
262.	MECHANICAL EQUIPMENT	8,266,332	152728 MH	2,036,630	346,593	10,649,555
26 .	MAIN COND HEAT REJECT SYS	6,351,535	217330 MH	2,834,302	956,228	12,142,065
2 .	TOTAL DIRECT COSTS	162,803,814	6520444 MH	85,863,029	55,134,276	303,801,119

PLANT CODE COST BASIS
640 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
795 MWE HIGH SULFUR COAL

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
911.	TEMPORARY CONSTRUCTION FAC		840000 MH	9,030,000	4,440,000	13,470,000
912.	CONSTRUCTION TOOLS & EQUIP		125000 MH	1,625,000	9,560,000	11,185,000
913.	PAYROLL INSURANCE & TAXES	13,935,000				13,935,000
914.	PERMITS,INS. & LOCAL TAXES				370,000	370,000
915.	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	13,935,000	965000 MH	10,655,000	14,370,000	38,960,000
921.	HOME OFFICE SERVICES	14,850,000				14,850,000
922.	HOME OFFICE Q/A					
923.	HOME OFFICE CONSTRCTN MGMT	985,000				985,000
92 .	HOME OFFICE ENGRG.&SERVICE	15,835,000				15,835,000
931.	FIELD OFFICE EXPENSES			800,000		800,000
932.	FIELD JOB SUPERVISION	9,990,000				9,990,000
933.	FIELD QA/QC	190,000				190,000
934.	PLANT STARTUP & TEST	435,000				435,000
93 .	FIELD OFFICE ENGRG&SERVICE	10,615,000		800,000		11,415,000
9 .	TOTAL INDIRECT COSTS	40,385,000	965000 MH	11,455,000	14,370,000	66,210,000
	TOTAL BASE COST	203,188,814	7485444 MH	97,318,029	69,504,276	370,011,119

Table 5-12

1243 MWe Low Sulfur Coal FPGS

Capital Cost Estimate

UNITED ENGINEERS & CONSTRUCTORS INC. SUMMARY PAGE 1

PLANT CODE 630

COST BASIS 01/78

ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE

1243 MWE LOW SULFUR COAL

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
20 .	LAND AND LAND RIGHTS				2,240,000	2,240,000
21 .	STRUCTURES + IMPROVEMENTS	2,644,148	1817885 MH	22,647,167	33,358,478	58,649,793
22 .	BOILER PLANT EQUIPMENT	97,656,527	2156877 MH	29,195,941	6,438,690	133,291,158
23 .	TURBINE PLANT EQUIPMENT	97,232,421	1838159 MH	25,020,360	5,696,298	127,949,079
24 .	ELECTRIC PLANT EQUIPMENT	9,049,020	1035632 MH	13,282,738	7,637,362	29,969,120
25 .	MISCELLANEOUS PLANT EQUIPT	6,256,902	258934 MH	3,527,595	869,267	10,653,764
26 .	MAIN COND HEAT REJECT SYS	10,802,776	268423 MH	3,503,926	1,158,081	15,464,783
2 .	TOTAL DIRECT COSTS	223,641,794	7375910 MH	97,177,727	57,398,176	378,217,697
91 .	CONSTRUCTION SERVICES	15,810,000	1080000 MH	11,825,000	17,965,000	45,600,000
92 .	HOME OFFICE ENGRG.&SERVICE	16,280,000				16,280,000
93 .	FIELD OFFICE ENGRG&SERVICE	12,300,000			1,010,000	13,310,000
9 .	TOTAL INDIRECT COSTS	44,390,000	1080000 MH	11,825,000	18,975,000	75,190,000
	TOTAL BASE COST	268,031,794	8455910 MH	109,002,727	76,373,176	453,407,697

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1243 MWE LOW SULFUR COAL

11/13/79

PLANT CODE 630
COST BASIS 01/78

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
20 .	LAND AND LAND RIGHTS				2,240,000	2,240,000
211.	YARDWORK	636,588	281920 MH	3,060,673	3,199,636	6,896,897
212.	STEAM GENERATOR BUILDING	503,006	622776 MH	8,148,673	16,862,622	25,514,301
213.	TURBINE,HEATER,CONTROL BLD	303,414	292753 MH	3,812,932	6,300,095	10,416,441
218B.	ADMINISTRATION+SERVICE BLG	238,129	67996 MH	883,183	924,196	2,045,508
218D.	FIRE PUMPHOUSE					
218I.	ELECTRICAL SWITCHGR BLDGS	24,028	7210 MH	93,453	50,265	167,746
218L.	STACK/RECLAIM TRANSFR TOWR	6,070	9792 MH	121,724	93,858	221,652
218M.	COAL CAR THAW SHED		2319 MH	28,393	13,868	42,261
218N.	ROTARY CAR DUMP BLDG+TUNNL	3,917	40006 MH	500,245	405,098	909,260
218O.	DEAD STORAGE RECLM HOPPERS		20995 MH	258,153	205,110	463,263
218P.	COAL CRUSHER HOUSE	92,019	17226 MH	230,311	245,610	567,940
218Q.	BOILER HOUSE TRANSFR TOWER	3,012	5987 MH	82,699	148,449	234,160
218R.	DEAD STORAGE TRANSFER TUNL		53295 MH	647,951	439,724	1,087,675
218T.	LOCOMOTIVE REPAIR GARAGE	13,005	4912 MH	64,616	72,578	150,199
218U.	MATERIAL HANDL+SERVICE BLD	15,438	10750 MH	141,819	154,821	312,078
218V.	WASTE WATER TREATMENT BLDG	5,522	11624 MH	146,905	103,434	255,861
218W.	MISC COAL HANDLING STRUCT	800,000	194866 MH	2,107,074	1,504,374	4,411,448
219.	STACK STRUCTURE		173458 MH	2,318,363	2,634,740	4,953,103
21 .	STRUCTURES + IMPROVEMENTS	2,644,148	1817885 MH	22,647,167	33,358,478	58,649,793

PLANT CODE COST BASIS
630 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1243 MWE LOW SULFUR COAL

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
**********	**************************	*************	************	*************	*************	**************
220A.	**FOSSIL STEAM SUPPLY SYSTEM**	**62,965,925**	**1158000 MH**	15,495,198	1,549,520	80,010,643
221.	STEAM GENERATING SYSTEM	1,347,814	37651 MH	519,811	62,949	1,930,574
222.	DRAFT SYSTEM	15,184,535	439685 MH	6,179,414	1,899,123	23,263,072
223.	ASH + DUST HANDLING SYSTEM	4,588,870	109115 MH	1,493,789	201,992	6,284,651
224.	FUEL HANDLING SYSTEMS	10,673,735	220446 MH	3,080,839	1,032,985	14,787,559
227.	INSTRUMENTATION + CONTROL	2,709,328	53620 MH	683,284	36,203	3,428,815
228.	BOILER PLANT MISC ITEMS	186,320	138360 MH	1,743,606	1,655,918	3,585,844
22 .	BOILER PLANT EQUIPMENT	97,656,527	2156877 MH	29,195,941	6,438,690	133,291,158
231.	TURBINE GENERATOR	60,117,532	347571 MH	4,552,781	1,700,629	66,370,942
233.	CONDENSING SYSTEMS	8,708,805	164659 MH	2,318,240	340,851	11,367,896
234.	FEED HEATING SYSTEM	15,511,365	312966 MH	4,319,325	433,028	20,263,718
235.	OTHER TURBINE PLANT EQUIP.	12,789,759	920340 MH	12,685,131	1,291,305	26,766,195
236.	INSTRUMENTATION + CONTROL	104,960	823 MH	10,488	524	115,972
237.	TURBINE PLANT MISC ITEMS		91800 MH	1,134,395	1,929,961	3,064,356
23 .	TURBINE PLANT EQUIPMENT	97,232,421	1838159 MH	25,020,360	5,696,298	127,949,079

PLANT CODE 630 COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1243 MWE LOW SULFUR COAL

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
241.	SWITCHGEAR	4,129,000	53380 MH	695,584	75,706	4,900,290
242.	STATION SERVICE EQUIPMENT	3,701,000	54590 MH	704,607	131,663	4,537,270
243.	SWITCHBOARDS	555,000	10530 MH	136,956	66,028	757,984
244.	PROTECTIVE EQUIPMENT		73400 MH	946,806	633,325	1,580,131
245.	ELECT.STRUC +WIRING CONTNR		466762 MH	5,961,055	2,117,910	8,078,965
246.	POWER & CONTROL WIRING	664,020	376970 MH	4,837,730	4,612,730	10,114,480
24 .	ELECTRIC PLANT EQUIPMENT	9,049,020	1035632 MH	13,282,738	7,637,362	29,969,120
251.	TRANSPORTATION & LIFT EQPT	1,384,114	8125 MH	111,160	98,886	1,594,160
252.	AIR,WATER+STEAM SERVICE SY	3,407,285	182401 MH	2,510,860	316,223	6,234,368
253.	COMMUNICATIONS EQUIPMENT	100,000	25000 MH	320,830	155,167	575,997
254.	FURNISHINGS + FIXTURES	721,801	6717 MH	83,031	17,323	822,155
255.	WASTE WATER TREATMENT EQPT	643,702	36691 MH	501,714	281,668	1,427,084
25 .	MISCELLANEOUS PLANT EQUIPT	6,256,902	258934 MH	3,527,595	869,267	10,653,764
261.	STRUCTURES	98,026	80751 MH	996,805	741,885	1,836,716
262.	MECHANICAL EQUIPMENT	10,704,750	187672 MH	2,507,121	416,196	13,628,067
26 .	MAIN COND HEAT REJECT SYS	10,802,776	268423 MH	3,503,926	1,158,081	15,464,783
2 .	TOTAL DIRECT COSTS	223,641,794	7375910 MH	97,177,727	57,398,176	378,217,697

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
1243 MWE LOW SULFUR COAL

11/13/79

PLANT CODE 630

COST BASIS 01/78

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
911.	TEMPORARY CONSTRUCTION FAC		920000 MH	9,745,000	4,680,000	14,425,000
912.	CONSTRUCTION TOOLS & EQUIP		160000 MH	2,080,000	12,830,000	14,910,000
913.	PAYROLL INSURANCE & TAXES	15,810,000				15,810,000
914.	PERMITS,INS. & LOCAL TAXES				455,000	455,000
915.	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	15,810,000	1080000 MH	11,825,000	17,965,000	45,600,000
921.	HOME OFFICE SERVICES	15,210,000				15,210,000
922.	HOME OFFICE Q/A					
923.	HOME OFFICE CONSTRCTN MGMT	1,070,000				1,070,000
92 .	HOME OFFICE ENGRG.&SERVICE	16,280,000				16,280,000
931.	FIELD OFFICE EXPENSES				1,010,000	1,010,000
932.	FIELD JOB SUPERVISION	11,625,000				11,625,000
933.	FIELD QA/QC	215,000				215,000
934.	PLANT STARTUP & TEST	460,000				460,000
93 .	FIELD OFFICE ENGRG&SERVICE	12,300,000			1,010,000	13,310,000
9 .	TOTAL INDIRECT COSTS	44,390,000	1080000 MH	11,825,000	18,975,000	75,190,000
	TOTAL BASE COST	268,031,794	8455910 MH	109,002,727	76,373,176	453,407,697

Table 5-13

802 MWe Low Sulfur Coal FPGS

Capital Cost Estimate

PLANT CODE 620
COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
802 MWE LOW SULFUR COAL

12/04/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
**********	*************************	*************	************	*************	*************	**************
20 .	LAND AND LAND RIGHTS				2,240,000	2,240,000
21 .	STRUCTURES + IMPROVEMENTS	2,196,990	1460805 MH	18,210,714	26,101,848	46,509,552
22 .	BOILER PLANT EQUIPMENT	71,540,603	1557257 MH	21,001,179	4,322,809	96,864,591
23 .	TURBINE PLANT EQUIPMENT	52,948,780	992078 MH	13,430,639	3,415,197	69,794,616
24 .	ELECTRIC PLANT EQUIPMENT	7,458,180	934424 MH	11,982,907	7,175,278	26,616,365
25 .	MISCELLANEOUS PLANT EQUIPT	5,680,520	221728 MH	3,014,847	753,144	9,448,511
26 .	MAIN COND HEAT REJECT SYS	8,351,535	217330 MH	2,834,302	956,228	12,142,065
2 .	TOTAL DIRECT COSTS	148,176,608	5383622 MH	70,474,588	44,964,504	263,615,700
91 .	CONSTRUCTION SERVICES	11,520,000	820000 MH	8,995,000	12,270,000	32,785,000
92 .	HOME OFFICE ENGRG.&SERVICE	13,805,000				13,805,000
93 .	FIELD OFFICE ENGRG&SERVICE	8,575,000			720,000	9,295,000
9 .	TOTAL INDIRECT COSTS	33,900,000	820000 MH	8,995,000	12,990,000	55,885,000
	TOTAL BASE COST	182,076,608	6203622 MH	79,469,588	57,954,504	319,500,700

PLANT CODE 620 COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
802 MWE LOW SULFUR COAL

12/04/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
20 .	LAND AND LAND RIGHTS				2,240,000	2,240,000
211.	YARDWORK	602,588	236870 MH	2,578,613	2,687,198	5,868,399
212.	STEAM GENERATOR BUILDING	410,241	463948 MH	6,057,618	12,224,636	18,692,495
213.	TURBINE,HEATER,CONTROL BLD	249,360	249981 MH	3,254,047	5,302,230	8,805,637
218B.	ADMINISTRATION+SERVICE BLD	218,446	61441 MH	798,040	811,329	1,827,815
218I.	ELECTRICAL SWITCHGR BLDGS	22,220	6649 MH	86,156	45,266	153,642
218L.	STACK/RECLAIM TRANSFR TOWR	4,710	7039 MH	87,707	66,851	159,268
218M.	COAL CAR THAW SHED		2319 MH	28,393	13,868	42,261
218N.	ROTARY CAR DUMP BLDG+TUNNL	3,917	40006 MH	500,245	405,098	909,260
218O.	DEAD STG RECLAIM HOPPER		20995 MH	258,153	205,110	463,263
218P.	COAL CRUSHER HOUSE	86,742	16000 MH	213,938	224,927	525,607
218Q.	BOILER HOUSE TRANSFR TOWER	2,001	3040 MH	41,584	76,753	120,338
218R.	DEAD STRG TRANSFER TUNNEL	12,800	39185 MH	476,412	309,890	799,102
218T.	LOCOMOTIVE REPAIR GARAGE	13,005	4912 MH	64,616	72,578	150,199
218U.	MATERIAL HANDL+SERVICE BLD	15,438	10750 MH	141,819	154,821	312,078
218V.	WASTE WATER TREATMENT BLDG	5,522	8841 MH	112,149	82,493	200,164
218W.	MISC COAL HANDLING STRUCT	550,000	142312 MH	1,554,239	1,190,810	3,295,049
219.	STACK STRUCTURE		146517 MH	1,956,985	2,227,990	4,184,975
21 .	STRUCTURES + IMPROVEMENTS	2,196,990	1460805 MH	18,210,714	26,101,848	46,509,552

PLANT CODE 620
COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
802 MWE LOW SULFUR COAL

12/04/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
220A.	FOSSIL STEAM SUPPLY SYSTEM	44,839,960	753315 MH	10,080,108	1,008,011	55,928,079
221.	STEAM GENERATING SYSTEM	1,054,205	28830 MH	398,094	50,778	1,503,077
222.	DRAFT SYSTEM	9,277,247	293353 MH	4,119,313	1,226,046	14,622,606
223.	ASH + DUST HANDLING SYSTEM	3,730,670	88031 MH	1,204,066	165,979	5,100,715
224.	FUEL HANDLING SYSTEMS	9,896,913	187008 MH	2,599,162	648,409	13,144,484
227.	INSTRUMENTATION + CONTROL	2,555,288	81040 MH	1,032,701	71,477	3,659,466
228.	BOILER PLANT MISC ITEMS	186,320	125680 MH	1,567,735	1,152,109	2,906,164
22 .	BOILER PLANT EQUIPMENT	71,540,603	1557257 MH	21,001,179	4,322,809	96,864,591
231.	TURBINE GENERATOR	31,171,795	237233 MH	3,114,738	1,016,933	35,303,466
233.	CONDENSING SYSTEMS	6,713,688	127632 MH	1,799,891	235,263	8,748,842
234.	FEED HEATING SYSTEM	8,961,325	175518 MH	2,423,265	243,441	11,628,031
235.	OTHER TURBINE PLANT EQUIP.	5,997,012	372962 MH	5,140,516	541,316	11,678,844
236.	INSTRUMENTATION + CONTROL	104,960	823 MH	10,488	524	115,972
237.	TURBINE PLANT MISC ITEMS		77910 MH	941,741	1,377,720	2,319,461
23 .	TURBINE PLANT EQUIPMENT	52,948,780	992078 MH	13,430,639	3,415,197	69,794,616

PLANT CODE 620
COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
802 MWE LOW SULFUR COAL

12/04/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
241.	SWITCHGEAR	3,416,400	44140 MH	575,179	60,592	4,052,171
242.	STATION SERVICE EQUIPMENT	3,057,500	45943 MH	593,262	109,314	3,760,076
243.	SWITCHBOARDS	458,000	9030 MH	117,410	64,073	639,483
244.	PROTECTIVE EQUIPMENT		72400 MH	933,972	601,325	1,535,297
245.	ELECT.STRUC +WIRING CONTNR		439676 MH	5,614,946	1,994,310	7,609,256
246.	POWER & CONTROL WIRING	526,280	323235 MH	4,148,138	4,345,664	9,020,082
24 .	ELECTRIC PLANT EQUIPMENT	7,458,180	934424 MH	11,982,907	7,175,278	26,616,365
251.	TRANSPORTATION & LIFT EQPT	1,308,438	7200 MH	98,424	97,612	1,504,474
252.	AIR,WATER+STEAM SERVICE SY	2,930,145	154351 MH	2,124,692	272,738	5,327,575
253.	COMMUNICATIONS EQUIPMENT	100,000	25000 MH	320,830	155,167	575,997
254.	FURNISHINGS + FIXTURES	721,801	6717 MH	83,031	17,323	822,155
255.	WASTE WATER TREATMENT EQPT	620,136	28460 MH	387,870	210,304	1,218,310
25 .	MISCELLANEOUS PLANT EQUIPT	5,680,520	221728 MH	3,014,847	753,144	9,448,511
261.	STRUCTURES	85,203	64602 MH	797,672	609,635	1,492,510
262.	MECHANICAL EQUIPMENT	8,266,332	152728 MH	2,036,630	346,593	10,649,555
26 .	MAIN COND HEAT REJECT SYS	8,351,535	217330 MH	2,834,302	956,228	12,142,065
2 .	TOTAL DIRECT COSTS	148,176,608	5383622 MH	70,474,588	44,964,504	263,615,700

PLANT CODE 620 COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
802 MWE LOW SULFUR COAL

12/04/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
911.	TEMPORARY CONSTRUCTION FAC		710000 MH	7,565,000	3,750,000	11,315,000
912.	CONSTRUCTION TOOLS & EQUIP		110000 MH	1,430,000	8,200,000	9,630,000
913.	PAYROLL INSURANCE & TAXES	11,520,000				11,520,000
914.	PERMITS,INS. & LOCAL TAXES				320,000	320,000
915.	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	11,520,000	820000 MH	8,995,000	12,270,000	32,785,000
921.	HOME OFFICE SERVICES	12,820,000				12,820,000
922.	HOME OFFICE Q/A					
923.	HOME OFFICE CONSTRCTN MGMT	985,000				985,000
92 .	HOME OFFICE ENGRG.&SERVICE	13,805,000				13,805,000
931.	FIELD OFFICE EXPENSES				720,000	720,000
932.	FIELD JOB SUPERVISION	8,010,000				8,010,000
933.	FIELD QA/QC	170,000				170,000
934.	PLANT STARTUP & TEST	395,000				395,000
93 .	FIELD OFFICE ENGRG&SERVICE	8,575,000			720,000	9,295,000
9 .	TOTAL INDIRECT COSTS	33,900,000	820000 MH	8,995,000	12,990,000	55,885,000
	TOTAL BASE COST	182,076,608	6203622 MH	79,469,588	57,954,504	319,500,700

Table 5-14

630 MWe Coal Gasification Combined Cycle FPGS

Capital Cost Estimate

PLANT CODE 660

COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
630 MWE COAL GASIFICATION COMBINED CYCLE

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
20 .	LAND AND LAND RIGHTS				560,000	560,000
21 .	STRUCTURES + IMPROVEMENTS	1,719,921	601382 MH	7,609,356	9,992,145	19,321,422
22 .	GASIFIER/BOILER PLT EQUIP.	93,797,456	2858660 MH	38,978,457	2,122,283	134,898,196
23 .	TURBINE PLANT EQUIPMENT	77,178,525	1839597 MH	25,240,624	1,738,013	104,157,162
24 .	ELECTRIC PLANT EQUIPMENT	5,135,865	1322303 MH	16,983,582	8,053,885	30,173,332
25 .	MISCELLANEOUS PLANT EQUIPT	1,511,540	180540 MH	2,449,428	471,559	4,432,527
26 .	MAIN COND HEAT REJECT SYS	6,845,945	183599 MH	2,240,283	392,622	9,478,850
2 .	TOTAL DIRECT COSTS	186,189,252	6986081 MH	93,501,730	23,330,507	303,021,489
91 .	CONSTRUCTION SERVICES	15,145,000	990000 MH	10,960,000	16,100,000	42,205,000
92 .	HOME OFFICE ENGRG.&SERVICE	15,355,000				15,355,000
93 .	FIELD OFFICE ENGRG&SERVICE	11,040,000			865,000	11,905,000
9 .	TOTAL INDIRECT COSTS	41,540,000	990000 MH	10,960,000	16,965,000	69,465,000
	TOTAL BASE COST	227,729,252	7976081 MH	104,461,730	40,295,507	372,486,489

PLANT CODE 660   COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
630 MWE COAL GASIFICATION COMBINED CYCLE

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
20 .	LAND AND LAND RIGHTS				560,000	560,000
211.	YARDWORK	76,720	155070 MH	1,764,379	2,021,548	3,862,647
213.	TURBINE GENERATOR BLDG	293,509	190207 MH	2,534,011	4,964,744	7,792,264
214.	CONTROL BUILDING	83,668	46366 MH	603,955	603,595	1,291,218
218B.	ADMINISTRATION+SERVICE BLD		82200 MH	1,079,860	1,312,358	2,392,218
218C.	FUEL OIL STORAGE TANKS		7700 MH	104,912	73,629	178,541
218D.	FUEL OIL FORWARDING HOUSE	2,713	2986 MH	37,568	25,364	65,645
218I.	DIESEL GEN & SWITCHGR BLDG		16320 MH	208,496	234,878	443,374
218M.	COAL CAR THAW SHED		2205 MH	26,602	11,499	38,101
218N.	COAL UNLOADING FACILITY		3125 MH	37,608	22,670	60,278
218P.	COAL CRUSHER HOUSE		660 MH	8,474	6,461	14,935
218R.	ROTARY PLOW MAINTNCE SHED					
218T.	LOCOMOTIVE REPAIR GARAGE					
218U.	COAL HANDLING CNTRL HOUSE		930 MH	11,433	9,768	21,201
218V.	WATER TREATMENT BLDG.	11,361	17140 MH	214,416	177,640	403,417
218W.	MISC COAL HANDLING STRUCT		25900 MH	314,383	190,311	504,694
218Z.	MISC SMALL BUILDINGS				109,500	109,500
219A.	FLUE GAS STACK	689,850	38267 MH	491,420	77,806	1,259,076
219B.	VENT + FLARE STACK	562,100	12304 MH	171,839	150,374	884,313
21 .	STRUCTURES + IMPROVEMENTS	1,719,921	601382 MH	7,609,356	9,992,145	19,321,422

PLANT CODE 660

COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
630 MWE COAL GASIFICATION COMBINED CYCLE

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
221.	GASIFIER SYSTEM	40,782,561	1207555 MH	16,530,634	498,538	57,811,733
222.	DRAFT SYSTEM	1,666,400	45872 MH	637,534		2,323,934
223.	ASH HANDLING SYSTEM	941,585	45651 MH	624,465	63,341	1,629,391
224.	FUEL HANDLING SYSTEMS	4,108,986	129353 MH	1,780,979	939,028	6,828,993
225.	PARTICULATE REMOVAL SYSTEM	10,577,496	298568 MH	4,109,966		14,687,462
226.	DESULFURIZATION SYSTEM	12,246,704	345670 MH	4,758,355		17,005,059
227.	STEAM GENERATING SYSTEM	16,071,726	493689 MH	6,886,935	339,043	23,297,704
228.	INSTRUMENTATION + CONTROL	2,476,173	92400 MH	1,177,463	61,551	3,715,187
229.	BOILER PLANT MISC. ITEMS	4,905,825	199902 MH	2,472,126	220,782	7,598,733
22 .	GASIFIER/BOILER PLT EQUIP.	93,797,456	2858660 MH	38,978,457	2,122,283	134,898,196
231.	STEAM TURBINE GENERATOR	18,567,998	106100 MH	1,397,456	453,475	20,418,929
232.	GAS TURBINE GENERATORS	51,542,144	1428966 MH	19,656,453	141,771	71,340,368
233.	CONDENSING SYSTEMS	2,806,149	65239 MH	914,288	99,377	3,819,814
234.	FEED HEATING SYSTEM	2,703,775	67260 MH	928,720	80,771	3,713,266
235.	OTHER TURBINE PLANT EQUIP.	1,558,459	105582 MH	1,456,607	149,145	3,164,211
236.	INSTRUMENTATION + CONTROL					
237.	TURBINE PLANT MISC ITEMS		66450 MH	887,100	813,474	1,700,574
23 .	TURBINE PLANT EQUIPMENT	77,178,525	1839597 MH	25,240,624	1,738,013	104,157,162

PLANT CODE 660

COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
630 MWE COAL GASIFICATION COMBINED CYCLE

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
**********	**************************	*************	************	*************	*************	**************
241.	SWITCHGEAR	2,296,000	27312 MH	355,899	38,634	2,690,533
242.	STATION SERVICE EQUIPMENT	1,865,500	27825 MH	360,378	51,146	2,277,024
243.	SWITCHBOARDS	187,000	3370 MH	43,914	4,391	235,305
244.	PROTECTIVE EQUIPMENT		88600 MH	1,141,868	651,000	1,792,868
245.	ELECT.STRUC +WIRING CONTNR		611992 MH	7,853,814	2,216,530	10,070,344
246.	POWER & CONTROL WIRING	787,365	563204 MH	7,227,709	5,092,184	13,107,258
24 .	ELECTRIC PLANT EQUIPMENT	5,135,865	1322303 MH	16,983,582	8,053,885	30,173,332
251.	TRANSPORTATION & LIFT EQPT	237,240	2740 MH	37,717	57,553	332,510
252.	AIR,WATER+STEAM SERVICE SY	980,320	138880 MH	1,911,031	365,727	3,257,078
253.	COMMUNICATIONS EQUIPMENT	151,500	37620 MH	482,785	48,279	682,564
254.	FURNISHINGS + FIXTURES	142,480	1300 MH	17,895		160,375
25 .	MISCELLANEOUS PLANT EQUIPT	1,511,540	180540 MH	2,449,428	471,559	4,432,527
261.	STRUCTURES	4,046	25567 MH	321,902	211,295	537,243
262.	MECHANICAL EQUIPMENT	6,841,899	158032 MH	1,918,381	181,327	8,941,607
26 .	MAIN COND HEAT REJECT SYS	6,845,945	183599 MH	2,240,283	392,622	9,478,850
2 .	TOTAL DIRECT COSTS	186,189,252	6986081 MH	93,501,730	23,330,507	303,021,489

PLANT CODE 660   COST BASIS 01/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
630 MWE COAL GASIFICATION COMBINED CYCLE

11/13/79

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
911.	TEMPORARY CONSTRUCTION FAC		850000 MH	9,140,000	4,510,000	13,650,000
912.	CONSTRUCTION TOOLS & EQUIP		140000 MH	1,820,000	11,220,000	13,040,000
913.	PAYROLL INSURANCE & TAXES	15,145,000				15,145,000
914.	PERMITS,INS. & LOCAL TAXES				370,000	370,000
915.	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	15,145,000	990000 MH	10,960,000	16,100,000	42,205,000
921.	HOME OFFICE SERVICES	14,370,000				14,370,000
922.	HOME OFFICE Q/A					
923.	HOME OFFICE CONSTRCTN MGMT	985,000				985,000
92 .	HOME OFFICE ENGRG.&SERVICE	15,355,000				15,355,000
931.	FIELD OFFICE EXPENSES				865,000	865,000
932.	FIELD JOB SUPERVISION	10,390,000				10,390,000
933.	FIELD QA/QC	200,000				200,000
934.	PLANT STARTUP & TEST	450,000				450,000
93 .	FIELD OFFICE ENGRG&SERVICE	11,040,000			865,000	11,905,000
9 .	TOTAL INDIRECT COSTS	41,540,000	990000 MH	10,960,000	16,965,000	69,465,000
	TOTAL BASE COST	227,729,252	7976081 MH	104,461,730	40,295,507	372,486,489

Table 5-15

Coal Liquefaction Plant

Capital Cost Estimate

Effective Date - 1/1/78

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) INITIAL UPDATE
COAL LIQUEFACTION PLANT

TOTAL CAPITAL COSTS
(Millions of 1/78 Dollars)

System	Recycle SRC Process	
	Liquid	Solid
Coal Preparation	88	88
Hydrogenation	300	249
Hydrogen Recycle	99	35
Fractionation	24	34
Hydrogen Plant	301	223
Filtration	-	142
Product Solidification	-	24
Gas and Secondary Recovery	127	103
Utilities and Offsites	124	118
General Facilities	83	83
Subtotal	1146	1099
Other Capital Costs	86	90
TOTAL	1232	1189

Effective Date - 1/1/78

TABLE 5-16

ENERGY ECONOMIC DATA BASE

COMMODITY AND CRAFT MANHOUR SUMMARY

1190 MWe BOILING WATER REACTOR NUCLEAR POWER GENERATING STATION

NUCLEAR PLANT QUANTITIES

Commodity	Unit	Quantity	Cost/Unit
Excavation	CY	536,000	8.82
Fill	CY	396,000	2.17
Formwork	SF	2,397,000	10.31
Reinforcing Steel	TN	20,400	1,047.00
Concrete	CY	204,000	65.99
Embedded Steel	TN	697	5,165.00
Structural Steel	TN	10,800	1,121.00
Special Steel Liners	LT	--	23.69*
Carbon Steel Piping (NS)	LB	1,652,000	10.96
Stainless Steel Piping (NS)	LB	195,000	43.87
Carbon Steel Piping (NNS)	LB	4,576,000	5.46
Stainless Steel Piping (NNS)	LB	333,000	15.84

Commodity (cont'd)	Unit	Quantity	Cost/Unit
Valves	LT	--	11.49*
Fire Protection	LT	--	0.52*
BOP Pump (1000 HP & above)	HP	57,400	102.64
Heat Exchangers	LT	--	21.06*
Turbine Generator	LT	--	54.41*
Instrumentation and Control	LT	--	11.89*
Lighting	LT	--	2.43*
Duct Runs and Containers	LF	504,000	17.63
Wire and Cable	LF	4,550,000	3.04
Electrical Balance of Plant	LT	--	19.12*
Nuclear Steam Supply System	LT	--	62.51*
All Others	LT	--	341.04*

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*Cost per unit is in dollars per kilowatt (NS) = Nuclear Safety Grade (NNS) = Non-Nuclear Safety Grade

NUCLEAR PLANT MANHOURS

Craft	Manhours	Cost
Boiler Makers	416,327	6,185
Carpenters	1,510,237	18,557
Electricians	1,761,952	22,765
Ironworkers	1,655,043	23,534
Laborers	1,425,677	13,661

Craft (cont'd)	Manhours	Cost
Millwrights	214,072	2,877
Operating Engineers	1,005,898	14,029
Pipe Fitters	3,001,651	42,658
Sheet Metal Workers	151,744	1,934
All Others	693,932	7,943
TOTAL CRAFT LABOR	11,836,533	154,143.

Effective Date - 1/1/78

TABLE 5-17

ENERGY ECONOMIC DATA BASE

COMMODITY AND CRAFT MANHOUR SUMMARY

1330 MWe HIGH TEMPERATURE GAS-COOLED REACTOR NUCLEAR POWER GENERATING STATION

NUCLEAR PLANT QUANTITIES

Commodity	Unit	Quantity	Cost/Unit
Excavation	CY	319,000	7.84
Fill	CY	191,000	3.76
Formwork	SF	1,382,000	11.03
Reinforcing Steel	TN	17,500	1,068.00
Concrete	CY	135,000	66.96
Embedded Steel	TN	731	5,165.00
Structural Steel	TN	9,700	1,121.00
Special Steel Liners	LT	--	8.68*
Carbon Steel Piping (NS)	LB	1,377,000	9.41
Stainless Steel Piping (NS)	LB	298,000	21.89
Carbon Steel Piping (NNS)	LB	2,273,000	5.11
Stainless Steel Piping (NNS)	LB	764,000	12.41

Commodity (cont'd)	Unit	Quantity	Cost/Unit
Valves	LT	--	11.18*
Fire Protection	LT	--	0.63*
BOP Pump (1000 HP & above)	HP	82,500	75.40
Heat Exchangers	LT	--	17.33*
Turbine Generator	LT	--	42.71*
Instrumentation and Control	LT	--	4.03*
Lighting	LT	--	1.76*
Duct Runs and Containers	LF	484,000	15.86
Wire and Cable	LF	4,511,000	3.00
Electrical Balance of Plant	LT	--	15.71*
Nuclear Steam Supply System	LT	--	164.47*
All Others	LT	--	254.11*

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*Cost per unit is in dollars per kilowatt (NS) = Nuclear Safety Grade (NNS) = Non-Nuclear Safety Grade

NUCLEAR PLANT MANHOURS

Craft	Manhours	Cost
Boiler Makers	547,513	8,148
Carpenters	1,041,780	12,806
Electricians	1,654,131	21,369
Ironworkers	1,211,898	17,234
Laborers	1,029,204	9,857

Craft (cont'd)	Manhours	Cost
Millwrights	198,656	2,661
Operating Engineers	642,114	8,962
Pipe Fitters	1,991,111	28,292
Sheet Metal Workers	78,942	993
All Others	1,000,937	17,317
TOTAL CRAFT LABOR	9,396,286	127,639.

Effective Date - 1/1/78

TABLE 5-18

ENERGY ECONOMIC DATA BASE

COMMODITY AND CRAFT MANHOUR SUMMARY

1139 MWe PRESSURIZED WATER REACTOR NUCLEAR POWER GENERATING STATION

NUCLEAR PLANT QUANTITIES

Commodity	Unit	Quantity	Cost/Unit
Excavation	CY	529,000	8.89
Fill	CY	396,000	2.17
Formwork	SF	2,038,000	10.83
Reinforcing Steel	TN	21,600	1,083.00
Concrete	CY	172,000	66.33
Embedded Steel	TN	545	5,165.00
Structural Steel	TN	11,300	1,121.00
Special Steel Liners	LT	--	12.31*
Carbon Steel Piping (NS)	LB	1,295,000	10.62
Stainless Steel Piping (NS)	LB	544,000	32.91
Carbon Steel Piping (NNS)	LB	4,661,000	5.34
Stainless Steel Piping (NNS)	LB	306,000	16.10

Commodity (cont'd)	Unit	Quantity	Cost/Unit
Valves	LT	--	10.37*
Fire Protection	LT	--	0.55*
BOP Pump (1000 HP & above)	HP	55,500	106.05
Heat Exchangers	LT	--	22.96*
Turbine Generator	LT	--	55.82*
Instrumentation and Control	LT	--	11.66*
Lighting	LT	--	2.64*
Duct Runs and Containers	LF	494,000	17.50
Wire and Cable	LF	4,609,000	3.01
Electrical Balance of Plant	LT	--	18.76*
Nuclear Steam Supply System	LT	--	64.32*
All Others	LT	--	344.87*

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*Cost per unit is in dollars per kilowatt (NS) = Nuclear Safety Grade (NNS) = Non-Nuclear Safety Grade

NUCLEAR PLANT MANHOURS

Craft	Manhours	Cost
Boiler Makers	616,928	9,174
Carpenters	1,414,162	17,378
Electricians	1,733,174	22,390
Ironworkers	1,372,166	19,509
Laborers	1,345,973	12,894

Craft (cont'd)	Manhours	Cost
Millwrights	164,996	2,218
Operating Engineers	836,021	11,670
Pipe Fitters	2,903,443	41,251
Sheet Metal Workers	121,248	1,540
All Others	621,789	7,108
TOTAL CRAFT LABOR	11,129,900	145,132.

[redacted] [redacted]

Effective Date - 1/1/78

TABLE 5-19

ENERGY ECONOMIC DATA BASE

COMMODITY AND CRAFT MANHOUR SUMMARY

1162 MWe PRESSURIZED HEAVY WATER REACTOR NUCLEAR POWER GENERATING STATION

NUCLEAR PLANT QUANTITIES

Commodity	Unit	Quantity	Cost/Unit
Excavation	CY	523,000	8.88
Fill	CY	398,000	2.25
Formwork	SF	1,963,000	11.93
Reinforcing Steel	TN	25,700	1,104.00
Concrete	CY	185,000	67.58
Embedded Steel	TN	706	5,165.00
Structural Steel	TN	9,800	1,121.00
Special Steel Liners	LT	--	14.97*
Carbon Steel Piping (NS)	LB	1,930,000	13.96
Stainless Steel Piping (NS)	LB	81,000	38.35
Carbon Steel Piping (NNS)	LB	4,624,000	5.26
Stainless Steel Piping (NNS)	LB	110,000	15.99
Commodity (cont'd)			
Valves	LT	--	9.10*
Fire Protection	LT	--	0.16*
BOP Pump (1000 HP & above)	HP	73,750	95.26
Heat Exchangers	LT	--	30.30*
Turbine Generator	LT	--	57.08*
Instrumentation and Control	LT	--	10.61*
Lighting	LT	--	2.01*
Duct Runs and Containers	LF	542,000	17.68
Wire and Cable	LF	5,174,000	2.96
Electrical Balance of Plant	LT	--	20.41*
Nuclear Steam Supply System	LT	--	97.93*
All Others	LT	--	366.91*

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*Cost per unit is in dollars per kilowatt (NS) = Nuclear Safety Grade (NNS) = Non-Nuclear Safety Grade

NUCLEAR PLANT MANHOURS

Craft	Manhours	Cost
Boiler Makers	815,045	12,119
Carpenters	1,526,860	18,766
Electricians	1,911,736	24,690
Ironworkers	1,626,631	23,135
Laborers	1,454,462	13,929
Craft (cont'd)		
Millwrights	198,525	2,675
Operating Engineers	931,369	12,996
Pipe Fitters	3,084,927	43,837
Sheet Metal Workers	62,658	802
All Others	742,635	7,481
TOTAL CRAFT LABOR	12,354,848	160,430.

Effective Date - 1/1/78

TABLE 5-20

ENERGY ECONOMIC DATA BASE

COMMODITY AND CRAFT MANHOUR SUMMARY

1232 MWe HIGH SULFUR COAL-FIRED FOSSIL POWER GENERATING STATION

COMPARISON COAL PLANT QUANTITIES

Commodity	Unit	Quantity	Cost/Unit
Excavation	CY	220,000	6.23
Fill	CY	99,000	6.39
Formwork	SF	1,065,000	6.15
Reinforcing Steel	TN	7,000	835.00
Concrete	CY	108,000	47.01
Embedded Steel	TN	369	4,329.00
Structural Steel	TN	29,200	1,027.00
Special Steel Liners	LT	--	1.22*
Carbon Steel Piping	LB	7,592,000	4.05
Stainless Steel Piping	LB	600	17.29
Chrome-Moly Piping	LB	3,219,000	6.69
Valves	LT	--	2.82*
Fire Protection	LT	--	0.42*
Pumps (1000 HP & up)	HP	102,750	68.00
Heat Exchanger	LT	--	17.32*
Turbine Generator	LT	--	50.84*
Coal Handling	TN/H	--	18,235.00
Dust Col. & Elec. Precipitator	LT	--	11.71*
Fans & Blowers (1000 HP & up)	HP	12,250	174.57
Heat.,Ventilating, & Air Cond.	LT	--	8.95*
Ash Handling	LT	--	4.41*
Instrumentation and Control	LT	--	3.06*
Lighting	LT	--	1.47*
Duct Runs & Wire Containers	LF	646,000	14.11
Wire and Cable	LF	3,986,000	3.05
Electrical Balance of Plant	LT	--	12.85*
Fossil Steam Supply System	LT	--	50.21*
All Others	LT	--	301.64*

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*Cost per unit is in dollars per kilowatt

COMPARISON COAL PLANT MANHOURS

Craft	Manhours	Cost
Boiler Makers	221,685	3,301
Carpenters	390,106	4,793
Electricians	1,482,140	19,147
Ironworkers	934,072	13,281
Laborers	616,609	5,910
Millwrights	165,358	2,218
Operating Engineers	610,095	8,515
Pipe Fitters	2,370,050	33,677
Sheet Metal Workers	@	@
All Others	2,130,379	27,314
TOTAL CRAFT LABOR	8,920,494	118,156.

@ Not Applicable

Effective Date - 1/1/78

TABLE 5-21

ENERGY ECONOMIC DATA BASE

COMMODITY AND CRAFT MANHOUR SUMMARY

795 MWe HIGH SULFUR COAL-FIRED FOSSIL POWER GENERATING STATION

COMPARISON COAL PLANT QUANTITIES

Commodity	Unit	Quantity	Cost/Unit
Excavation	CY	180,000	6.49
Fill	CY	84,000	6.25
Formwork	SF	896,000	5.97
Reinforcing Steel	TN	5,500	832.00
Concrete	CY	88,000	46.74
Embedded Steel	TN	300	4,329.00
Structural Steel	TN	22,000	1,027.00
Special Steel Liners	LT	--	1.58*
Carbon Steel Piping	LB	4,985,000	4.03
Stainless Steel Piping	LB	600	17.29
Chrome-Moly Piping	LB	1,212,000	6.79
Valves	LT	--	3.36*
Fire Protection	LT	--	0.62*
Pumps (1000 HP & up)	HP	66,320	75.95
Heat Exchanger	LT	--	18.87*
Turbine Generator	LT	--	41.48*
Coal Handling	TN/H	--	25,287.00
Dust Col. & Elec. Precipitator	LT	--	11.37*
Fans & Blowers (1000 HP & up)	HP	8,750	174.57
Heat.,Ventilating, & Air Cond.	LT	--	9.20*
Ash Handling	LT	--	5.79*
Instrumentation and Control	LT	--	4.96*
Lighting	LT	--	1.86*
Duct Runs & Wire Containers	LF	568,000	14.07
Wire and Cable	LF	3,421,000	3.07
Electrical Balance of Plant	LT	--	17.62*
Fossil Steam Supply System	LT	--	55.00*
All Others	LT	--	327.13*

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*Cost per unit is in dollars per kilowatt

COMPARISON COAL PLANT MANHOURS

Craft	Manhours	Cost
Boiler Makers	166,433	2,468
Carpenters	319,555	3,920
Electricians	1,277,523	16,511
Ironworkers	722,168	10,266
Laborers	493,918	4,732
Millwrights	127,015	1,707
Operating Engineers	447,280	6,240
Pipe Fitters	1,503,977	21,371
Sheet Metal Workers	@	@
All Others	1,462,671	18,648
TOTAL CRAFT LABOR	6,520,540	85,863.

@Not Applicable

Effective Date - 1/1/78

TABLF 5-22

ENERGY ECONOMIC DATA BASE

COMMODITY AND CRAFT MANHOUR SUMMARY

1243 MWe LOW SULFUR COAL-FIRED FOSSIL POWER GENERATING STATION

COMPARISON COAL PLANT QUANTITIES

Commodity	Unit	Quantity	Cost/Unit
Excavation	CY	169,000	5.82
Fill	CY	107,000	6.18
Formwork	SF	719,000	5.96
Reinforcing Steel	TN	5,300	840.00
Concrete	CY	77,300	47.29
Embedded Steel	TN	300	4,329.00
Structural Steel	TN	23,000	1,027.00
Special Steel Liners	LT	--	1.21*
Carbon Steel Piping	LB	4,585,000	4.11
Stainless Steel Piping	LB	600	17.29
Chrome-Moly Piping	LB	3,219,000	6.69
Valves	LT	--	2.63*
Fire Protection	LT	--	0.43*
Pumps (1000 HP & up)	HP	103,750	68.00
Commodity (cont'd)			
Heat Exchanger	LT	--	17.16*
Turbine Generator	LT	--	50.39*
Coal Handling	TN/H	--	19,027.00
Dust Col. & Elec. Precipitator	LT	--	13.00*
Fans & Blowers (1000 HP & up)	HP	--	--
Heat.,Ventilating, & Air Cond.	LT	--	4.44*
Ash Handling	LT	--	3.90*
Instrumentation and Control	LT	--	2.64*
Lighting	LT	--	1.29*
Duct Runs & Wire Containers	LF	527,000	14.09
Wire and Cable	LF	3,336,000	3.05
Electrical Balance of Plant	LT	--	10.84*
Fossil Steam Supply System	LT	--	50.66*
All Others	LT	--	253.62*

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*Cost per unit is in dollars per kilowatt

COMPARISON COAL PLANT MANHOURS

Craft	Manhours	Cost
Boiler Makers	209,934	3,122
Carpenters	269,068	3,306
Electricians	1,221,614	15,788
Ironworkers	733,908	10,437
Laborers	631,304	6,044
Craft (cont'd)		
Millwrights	146,994	1,976
Operating Engineers	493,654	6,896
Pipe Fitters	1,796,642	25,521
Sheet Metal Workers	@	@
All Others	1,872,888	24,087
TOTAL CRAFT LABOR	7,376,006	97,177

@Not Applicable

Effective Date - 1/1/78

TABLE 5-23

ENERGY ECONOMIC DATA BASE

COMMODITY AND CRAFT MANHOUR SUMMARY

802 MWe LOW SULFUR COAL-FIRED FOSSIL POWER GENERATING STATION

COMPARISON COAL PLANT QUANTITIES

Commodity	Unit	Quantity	Cost/Unit
Excavation	CY	136,000	6.04
Fill	CY	90,000	6.09
Formwork	SF	603,000	5.75
Reinforcing Steel	TN	4,100	836.00
Concrete	CY	64,000	46.93
Embedded Steel	TN	248	4,329.00
Structural Steel	TN	17,600	1,027.00
Special Steel Liners	LT	--	1.56*
Carbon Steel Piping	LB	2,926,100	4.10
Stainless Steel Piping	LB	600	17.29
Chrome-Moly Piping	LB	1,212,000	6.79
Valves	LT	--	3.11*
Fire Protection	LT	--	0.65*
Pumps (1000 HP & up)	HP	66,320	75.95
Commodity (cont'd)	**Unit**	**Quantity**	**Cost/Unit**
Heat Exchanger	LT	--	18.71*
Turbine Generator	LT	--	41.11*
Coal Handling	TN/H	--	25,584.00
Dust Col. & Elec. Precipitator	LT	--	12.75*
Fans & Blowers (1000 HP & up)	HP	--	--
Heat.,Ventilating, & Air Cond.	LT	--	4.66*
Ash Handling	LT	--	5.00*
Instrumentation and Control	LT	--	4.35*
Lighting	LT	--	1.68*
Duct Runs & Wire Containers	LF	497,000	14.06
Wire and Cable	LF	2,809,000	3.22
Electrical Balance of Plant	LT	--	14.46*
Fossil Steam Supply System	LT	--	55.91*
All Others	LT	--	272.79*

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*Cost per unit is in dollars per kilowatt

COMPARISON COAL PLANT MANHOURS

Craft	Manhours	Cost
Boiler Makers	154,184	2,289
Carpenters	219,438	2,691
Electricians	1,093,096	14,121
Ironworkers	563,516	8,020
Laborers	494,107	4,732
Craft (cont'd)	**Manhours**	**Cost**
Millwrights	113,411	1,519
Operating Engineers	357,402	4,983
Pipe Fitters	1,101,719	15,659
Sheet Metal Workers	@	@
All Others	1,286,834	16,460
TOTAL CRAFT LABOR	5,383,707	70,474

@Not Applicable

SECTION 6

6.0 FUEL CYCLE COST INITIAL UPDATE

The Initial Update of the fuel cycle costs in the Energy Economic Data Base consists of two parts: fissile-fuel-uranium and fossil-fuel-coal. The section on the nuclear fuel cycle costs is considerably more detailed than that for the coal fuels, because of the greater complexity of the former. Preparation of the EEDB is the first attempt at developing a comprehensive set of fuel cycle costs for all of the technical models in the Data Base, with a consistent and exhaustive set of ground-rules. Ground-rules and assumptions governing the fuel cycle costs are discussed in Section 3.

6.1 FUEL CYCLE COST UPDATE PROCEDURE

Since the compilation of fuel cycle costs for the Initial Update of the EEDB is a first-of-a-kind effort performed by NUS Corporation under contract to UE&C, no update procedure is presented. However, a standardized update procedure for future updates will be developed during Phase II of the EEDB program.

6.2 FUEL CYCLE COST SUMMARY

Fuel cycle costs are prepared for the EEDB as total thermal costs (¢/MBtu). Nuclear fuel cycle costs consist of Fuel, Fabrication, Transportation, Reprocessing, if used, and Disposal costs, while coal fuel cycle costs consist of Fuel and Transportation costs only. Fuel cycle costs are summarized in Table 6-1 for all plants for startups in the year 2001. Tables 6-2 and 6-3 summarize the same data for applicable plants, except that year 1978 plant startups and commercialized technologies are given in Table 6-2. Table 6-3 gives data for variable year plant startups for the year when the technologies are expected to be deployed commercially. Both Tables 6-2 and 6-3 include the LWR plants for comparison.

6.3 DETAILED FUEL CYCLE COSTS

Results of the Fuel Cycle Costs Initial Update are presented for each technical plant model in the Tables listed below. Specific BWR mass flow data was not available for this study. Therefore, PWR data is used for the BWR (Model A1) as discussed in subsection 6.5.4.

Nuclear Plant Model	Year of Startup	Table Number
PWR	1978	6-4a/4b
PWR	1987	6-5a/5b
PWR	2001	6-6a/6b
HTGR	1995	6-7a/7b
HTGR	2001	6-8a/8b
PHWR	1995	6-9a/9b
PHWR	2001	6-10a/10b
GCFR	2001	6-11a/11b
LMFBR	2001	6-12a/12b

Fossil Plant Model	Year of Startup	Table Number
HS12	1978	6-13a
HS12	1987	6-13b
HS12	2001	6-13c
HS8	1978	6-13a
HS8	1987	6-13b
HS8	2001	6-13c
LS12	1978	6-13a
LS12	1987	6-13b
LS12	2001	6-13c
LS8	1978	6-13a
LS8	1987	6-13b
LS8	2001	6-13c
CGCC	1987	6-13b
CGCC	2001	6-13c
CLIQ	1987	6-13b
CLIQ	2001	6-13c

For the nuclear fuel cycle costs, "a" tables tabulate Input Cost Components and "b" tables tabulate Output Cost Components.

In the "a" series of nuclear fuel cycle cost tables, the costs of the fuel cycle components are assumed to remain unchanged in terms of constant $1978, except for the following items:

a. U_3O_8 (yellowcake) costs which are assumed to increase because of increasing scarcity from 1978 through 1990 at an average rate of 2.8 percent per year; from 1990 through 2000 at an average rate of one percent per year; and from 2000 through 2035 at an average rate of 0.26 percent per year.

b. Fuel reprocessing costs which vary with the type of fuel handled and are projected to show some slight decrease with time based on a learning curve assumption.

In the "b" series of nuclear fuel cycle cost tables, the costs are given for discrete years after plant startup and as levelized over the nominal 30-year plant lifetime. The values in the "a" tables are given in terms of unit costs and in the "b" tables are given in $/MBtu.

The costs are based on the mass flow characteristics of the specific reactor type for which the costs are computed, at equilibrium conditions. These characteristics are applied as derived coefficients to the unit costs for the materials/services given in the "a" tables. The resulting discrete annual direct costs and the levelized costs are given in constant $1978, which include no allowance for inflation, except as noted in the preceding paragraph. The costs for operating year one reflect the costs for the initial core; subsequent years' costs reflect the equilibrium operational conditions.

6.4 LEVELIZATION FOR NUCLEAR FUEL CYCLE COSTS

The levelized nuclear fuel cycle cost is calculated in accordance with the method given in Appendix F. In the detailed fuel cycle cost tables indexed in subsection 6.3, the fuel cycle cost is "levelized" over the projected plant life by dividing the total direct plus indirect cost estimates for the relevant time by the total energy generated over the same time period. The levelized costs thus include both the direct and the indirect costs.

6.5 NUCLEAR FUEL CYCLE COSTS

The costs included in the nuclear fuel cycle are necessary data for assessing the economics of the nuclear power generating station. To establish the nuclear fuel cycle costs, two major groups of data are required:

a. The characteristics of the nuclear reactor type under consideration which are given by the mass flows for the particular cycle involved.

b. The individual costs for each segment of the fuel cycle from the mining of ore through final disposition of radioactive waste or spent fuel elements.

Reactors for the nuclear power generating stations included in the EEDB are described in the Non-Proliferation Alternate Assessment Program and the designations for these plants are correlated with the applicable NASAP codes, as shown in Table 6-20.

The detailed costs of the nuclear fuel cycle are based on the steps in a typical uranium/plutonium fuel cycle illustrated in Figure 6.1 This Figure shows a complete reactor fuel cycle from mining of uranium ore through reprocessing of irradiated fuel, recovery of uranium and plutonium from spent fuel and shipment of high level waste to permanent storage. Under this scheme the uranium and plutonium are recycled through the reactor fuel cycle. It should be noted that the reprocessing portions of the fuel cycle shown in Figure 6.1 are included for completeness and to provide economic data for this option. Currently, reactor fuel is not being reprocessed. The alternate back-end of the fuel cycle without the reprocessing option is also shown in Figure 6.1 which shows temporary storage and eventual disposal of the spent fuel without reprocessing.

A standardized cost-code-of-accounts format for the presentation of the fuel cycle costs is developed using an extension of the format developed in USAEC Report NUS-531, "Guide for Economic Evaluation of Nuclear Reactor Plant Designs." The fuel cycle costs are expressed in terms of January 1978 dollars. The total fuel cycle cost is composed of the direct costs for materials and services for each step of the fuel cycle and of indirect costs which usually include interest on borrowed money, return on equity, federal and state income taxes, other taxes, and other costs associated with the time value of money. The direct costs are given in inflation-free dollars and the indirect costs are computed so that the effect of inflation is removed. Therefore, the data are given in constant dollars, as discussed in subsection 2.3. Use of inflation-free dollars for both direct and indirect costs also permits the selection of specific future operating dates, corresponding to the projected economic conditions.

The costs of materials and services involved in the nuclear fuel cycle affect the total fuel cycle costs in various degrees. The cost of U_3O_8 is the largest contributor to total costs, and changes in this component have the largest effect on the overall fuel cycle costs, for those systems requiring makeup U_3O_8. In the discussion of detail which follows in this section, the costs for the various steps are given in constant 1978 dollars (unless explicitly stated otherwise). In many cases, the costs of these fuel cycle steps remain constant or even decline with respect to time, because of such factors as the presumed savings resulting from familiarity with the processes or from the quantity of the system throughput. In other cases, notably that of the uranium ore, the costs may increase with time. In the context of this report this increase is not due to inflation, but rather to a change in the amount of effort required to extract ore from sources less rich in uranium and, therefore, requiring either additional processing steps or longer application of the same processing steps. Arbitrarily, this increase in cost, which arises from a real change in the amount of energy, labor and materials expended in producing the same product and quantity, is referred to as escalation caused by scarcity (e_s). This is an attempt to distinguish it from escalation caused by inflation (e_i), which represents a change in the value of money, rather than a change in the cost of the process. To illustrate the effect of cost changes on the fuel cycle, sensitivity studies are reported in NUS Corporation Report NUS-3190, "Fuel Cycle Cost Estimates for LWR, HTGR, CANDU - Type HWR, LMFBR and GCFR," which show the impact of a change in a particular fuel cycle step on the total fuel cost.

The fuel cycle costs for the life of the reactors, which are assumed in the study to be 30 years, are levelized to permit comparison of the various reactor fuel cycle options on the same economic basis.

6.5.1 Components of Nuclear Fuel Cycle Costs

The fuel cycle costs include the following direct costs representing goods and/or services and follow the steps in the fuel cycle as shown in Figure 6.1:

a. The cost of U_3O_8 in dollars per pound - \$/lb U_3O_8.

b. The cost per kilogram for conversion of the U_3O_8 to UF_6 - \$/Kg U.

c. The cost for enrichment of the UF_6 to the level required by the particular reactor fuel cycle under consideration. The cost is given in dollars per separative work unit - \$/SWU.

d. The cost for fabrication carrying the enriched UF_6 to pelletized UO_2 and encapsulating in a cladding material, followed by assembly of single fuel rods into a fuel element - \$/Kg U (or HM).

e. The costs for shipping fuel to the reactor site - the point of use - \$/Kg U (or HM); in this report, these costs are included in fabrication costs.

f. The cost of shipping spent fuel after on-site storage, to (a) reprocessing or (b) a Federal repository for spent fuel storage - \$/Kg HM.

g. The cost of spent fuel disposal - \$/Kg HM or

h. The cost for reprocessing of spent fuel - \$/Kg HM.

i. The cost for disposal of waste from the reprocessing operation - \$/Kg HM.

j. The cost/refund value of the recovered U or Pu as shipped for fuel fabrication of mixed oxide fuel - MOX - \$/Kg HM.

U_3O_8 = uranium ore concentrate

UO_2 = uranium oxide

HM = heavy metal

UF_6 = uranium hexafluoride

U = elemental uranium

The assignment of a determinate dollar value to the individual steps in the nuclear fuel cycle is open to much discussion. In the text and the tables that follow, the costs have been derived from the best information available to UE&C and its subcontractor, NUS Corporation. In specific cases, where the user of this information has reservations concerning the correctness of the values, the format permits the use of whatever value is deemed proper. It should be noted that the values used here represent a consensus of current estimates or actual costs as shown. Table 6-14 summarizes the fuel cycle unit prices used in this evaluation.

It must be noted that the costs for natural uranium are taken over the period from 1985 to 2035 and values for the intervening years are shown in Table 6-15.

Fuel fabrication costs depend on various fuel cycle options in the reactor types involved. These costs are summarized, by reactor type, in Table 6-16.

The shipping of fuel to a site usually constitutes a minor cost which is normally absorbed under fabrication. However, when mixed oxide fuels, which occur only in a recycle mode, are used or the LMFBR and GCFR cases are involved, the handling of the plutonium-rich material requires greater care and incurs greater shipping costs.

When the fuel elements are removed from the reactor, following the time cycle proper to each reactor type, they are generally stored in a safe and shielded area to permit the short-lived fission products to decay. Storage times may vary from as little as 120 days through 10 years or even longer. Under the assumptions of this study, the investment cost of this storage has been included in the capital cost of the plant which makes provision for the storage of spent fuel. Consequently, although the time value of money for the fuel storage period is included in the fuel cycle costs, there is no explicit charge given for onsite spent fuel storage facilities.

The shipping of spent fuel from the reactor site to a reprocessing plant or a temporary or permanent Federal repository for spent fuel elements, does require significant expenditures. These expenditures differ for the types of fuel shipped, and are shown in Table 6-17.

The projected reprocessing costs for different reactors at different times through approximately the next 30 years are shown in Table 6-18. In terms of constant dollars, it has been assumed that there will be some productivity increase with the passing of time and that this productivity increase will be accompanied by a reduction in the cost of operation.

Under the assumption that the reprocessing option is open to all nuclear plants both thermal and fast, the reprocessing wastes must be disposed of. Currently, the decision on selection of the method to be used for disposing of these wastes has not been resolved, but it is clear that the costs associated with such disposal must be included in the fuel cycle for each reactor type and fueling option. These are shown in Table 6-14 for three of the EEDB options.

The value of bred fuel in the context of this discussion has not been explicitly addressed. Bred fuel values are discussed in Appendix G. It is generally accepted that the value of the plutonium and of the uranium recovered in reprocessing, will be economically attractive only when that portion of the fuel cycle, with its attendant waste disposal, is shown to be less expensive than the use of fresh uranium and the subsequent steps of enrichment and fuel fabrication. For the fast breeder reactors (FBR's), the assumption is implicit that the plutonium will be bred from depleted U-238 which is considered to have no value.

6.5.2 Indirect Costs

In the discussion presented in the preceding paragraphs, the direct costs for the goods and/or services involved in each fuel cycle step are noted. In addition to these direct costs, there are other, related cost factors, which affect the overall fuel cycle cost. These indirect costs usually include:

- Interest on Borrowed Money
- Return on Equity
- Federal and State Income Taxes
- Other taxes
- Other costs related to the time-value of money

The calculation of indirect fuel cycle costs requires that all the factors affecting them be specified over the time period for which they are being calculated. Although it is desirable to establish a linear relationship to the direct costs, it frequently is not possible to do this. Indirect costs can be determined with precision only through a detailed cash flow analysis. However, adequate estimates of indirect costs can be derived by an interest rate approach which is derivable from the discount cash flow approach.

The indirect costs assigned to the fuel cycle are calculated by the NUS proprietary computer program FUELCOST-V, as equal to simple interest on the average balance over the period of energy production, at an interest rate equal to the discount rate, which in turn is approximately equivalent to a discount cash flow approach. The basis for this approach and for the categories of cost which are discussed below are derived from the USAEC report NUS-531, published in 1969. In computing the indirect costs, the values for taxes, the percent debt, the interest rate on debt, the percent of equity and the return on equity are average values taken from Federal Regulatory Energy Commission publications (formerly the Federal Power Commission). (See Appendix F)

6.5.3 Other Factors

To preserve consistency with the NASAP approach, the assumed lifetime of the operating plant is 30 years. To permit calculation of costs affecting start-up in different years in the future, certain assumptions for plant start-up were made. These are discussed in Section 3.2.3.

A constant operating capacity factor, CF, of 75 percent over the 30-year projected useful life of the plant, was assumed for all the reactor types, except the LMFBRs. The fuel cycles for the LMFBRs are arranged on an approximately annual basis but with varying capacity factors. Over the plant life, the annual CF begins at around 60 percent, increases to 72 percent CF after four years and continues at this level for the next 12 years. After 16 years, the CF begins to decrease, reaching 50 percent at the end of the 30 years plant life. Cost calculations for the LMFBRs were performed using a constant 75 percent CF which results in reduced fuel batch cycle lengths. The effect of this difference is small for the LMFBR base case: Scenario 1 (see Appendix G and Table 6-27).

The lag and lead times involved in the procurement of fuel and the reprocessing step (where reprocessing is involved) and the eventual crediting of the recovered materials, affect costs inasmuch as they represent a charge similar to an interest rate. The lead time is the length of time from the payment for materials and services at the beginning of the fuel cycle, to the time this fuel is placed in the reactor core. This lead time simulates the progress payment schedule. The lag time is the length of time from discharge of fuel from the reactor to the time of payments made for materials and/or services at the back-end of the cycle, and to the time of receipt of credit, if any, for the recovered fuel. A summary of the lead and lag times used in the fuel cycle studies is shown in Table 6-19.

In the various steps of the fuel cycles, where the fuel itself undergoes processing, some losses are inevitable. However, they are on the basis of experience considered to be too small to affect significantly the overall costs in any step of the fuel cycle. For all of the reactor types and fuel cycle options presented here, it is assumed that the tails assay for enrichment is approximately 0.2 weight percent U-235. Minor changes in the percentage of the tails assay are not expected to affect the costs of the fuel cycle significantly. Advanced isotope separation technology is not considered in this report.

6.5.4 Description of Reactor Types and Their Fuel Cycles

In the course of the NUS Corporation study, performed for the EEDB fuel cycle evaluation, the economics for the fuel cycles of a number of reactor types and their options were reviewed. The material presented here covers only those reactor types and options previously defined for the EEDB, and are summarized in Table 6-20. Table 6-21 gives a brief summary of the basic features of the baseline reactor types and their fuel cycles. A determination was made that differences between the two LWR types, the Boiling Water Reactor (BWR) and the Pressurized Water Reactor (PWR), have a relatively insignificant effect on the overall fuel cycle costs. Consequently, in performing the fuel cycle cost study, NUS Corporation, with the concurrence of DOE and UE&C, agreed that data developed for the PWR cases also apply to the BWR.

The fuel cycle cost calculations are based on the NASAP reactor design data. The rated powers of the nuclear systems studied in EEDB differ in some cases from the nominal thermal powers listed for the NASAP systems in Table 6-20. However, the mass flow relationships remain unchanged for a determinate reactor type over a relatively large range of output power. Thus, although the total mass of fuel used (200 MTU vs. 150 MTU) is different for two PWRs of different thermal power, the level of initial enrichment ($\sim$3%), the average burnup (30,000 MWd/T) and the heat rate (10,200 Btu/kWh) are approximately the same. Therefore, the total cost of fuel is different, but the specific costs in $/MBtu or mills/kWh, are the same for the same portions of the nuclear fuel cycle. Consequently, the differences between the EEDB nuclear systems rated power and the nominal NASAP rated power do not affect the calculated costs of the nuclear fuel cycle for the reactor types studied. As noted in the preceding paragraph, the real differences between the PWR and the BWR are insufficient to change the calculated costs for LWRs by a significant amount.

6.5.4.1 Light Water Reactors

Light water reactors, operating primarily on the thermal neutron spectrum, include the Boiling Water Reactor (BWR), and the Pressurized Water Reactor (PWR). The differences between the two reactor types with respect to the fuel cycle are relatively minor. In general, the BWR carries the burnup of its fuel in terms of megawatt-days-per-ton to a lower final level than the PWR. Related to this, are the differences in initial enrichment for the two reactor types, with the BWR having enrichments around 2.7 to 2.8 weight percent and the PWR having enrichments between 3.0 and 3.3 weight percent of fissile U-235.

A summary of a typical PWR design and a schematic of the PWR fuel cycle for both the disposal case and for the fuel reprocessing are shown in Table 6-22 and Figure 6.2. The steps in the fuel cycle corresponding to the schematic of Figure 6.2 are given in Figure 6.1. Table 6-23 shows the mass flow data for the typical BWR at the nominal 1200 MWe plant size used for the EEDB Initial Update; the BWR fuel cycle is identical to that shown in Figure 6.2.

The calculation of fuel cycle costs is based on equilibrium operation. The equilibrium operation assumes approximately uniform exposure of each batch of nuclear fuel. A batch is a quantity of reactor fuel which is some substantial fraction (0.25 - 0.33) of the total reactor core load. At initial plant startup a fully loaded core is in place. After about one year of operation a fraction of the core is replaced with fresh fuel. At intervals of about one year thereafter, additional equal core fractions are removed and replaced with fresh fuel, until the entire initial core has been replaced. Assuming that the core fraction removed/replaced is approximately one-third of the full core loading and that the reload interval is one year, the first segment of the initial core receives an exposure of one year and the last segment is exposed for three years. Subsequently, each batch is operational for about three years prior to replacement.

Data for the PWR were obtained from Combustion Engineering, Inc. for the system designed by them. Data for the BWR system were obtained from General Electric Company. The sources of data for the LWRs and the remaining reactor fuel cycles, discussed in this report, are given in Table 6-24.

6.5.4.2 The High Temperature Gas Cooled Reactor - HTGR

The plant design of the HTGR as well as the fuel block configuration permits a variety of fuel loadings in various configurations within the reactor core without changes in the plant design. The initial charge for the HTGR uses enriched uranium at an enrichment level of approximately 19.8 weight percent U-235. The balance of the fuel in these fuel rods is U-238. The chemical form of the fuel, unlike that used in the LWR, is uranium carbide. In addition to the uranium carbide fuel, other fuel elements can be made containing various mixtures of fissile or fertile materials. In the ideal case for the HTGR, the fertile material is thorium oxide. Neutron capture in the abundant (approximately 100 percent in nature) Th-232, produces a small number of fissions but results primarily in captures leading to Th-233, which upon beta decay becomes Pa-233, which also undergoes beta decay to become U-233. U-233 is a thermally fissile material suitable for use in thermal reactors as a direct substitute for U-235, the only thermally fissile material occurring naturally. Since the overall abundance of thorium in the earth's crust is believed to be about ten times that of uranium, the potential for converting significant portions of this material to U-233 is important. The mass flow characteristics for the HTGR are given in Table 6-25 and a schematic of the "throw-away" cycle and the U-233 recycle are shown in Figure 6.3. Only one full scale version of this reactor type has been operated in the United States. This is the Fort St. Vrain reactor in Colorado, which embodies a number of technological innovations, as well as the use of the HTGR fuel cycle. Information on the HTGR was provided by General Atomic Company.

6.5.4.3 The Pressurized Heavy Water Reactor - PHWR

The Pressurized Heavy Water Reactor, PHWR, in the EEDB is also referred to as the CANDU Heavy Water Reactor. (The acronym CANDU is derived from Canada Deuterium Uranium). It is based upon the concept of using natural uranium in a heavy water environment which serves as the moderator, with very low neutron absorption. Reactors of this type have been designed and built by Atomic Energy of Canada Limited. In the CANDU reactor the fuel elements are contained within pressure tubes along with their coolant. These are submerged in the heavy water moderator which is kept totally separated from the internal and pressurized water. Although the initial concept of the CANDU/PHWR envisioned a reactor using natural uranium fuel, which is uranium with the natural content of U-235, approximately 0.711 weight percent, more recent concepts have been investigated which use low enrichments, up to a level of about 1.2 weight percent U-235, in the reactor fuel. The low level of enrichment does not permit high burnup but the reactor does achieve good utilization of the slightly enriched uranium, and may yield a significant reduction in fuel cycle costs compared to a natural uranium cycle.

As shown in the fuel cycle schematic, Figure 6.4, as well as the design characteristics, Table 6-26, the PHWR/CANDU is operated without intentional recycle, i.e., without recovery of the U-238 or any bred plutonium which may be present in the spent fuel at the end of its cycle through the reactor. A batch of fuel remains in the PHWR/CANDU reactor for approximately one cycle of 3-1/4 years before being replaced by a fresh batch. No reactors of the

PHWR/CANDU type have yet been built in the United States. Data for the PHWR were provided by Combustion Engineering, Inc.

6.5.4.4 The Liquid Metal Fast Breeder Reactor - LMFBR

As the name of the reactor indicates, the LMFBR utilizes liquid metal coolant in the current design and fission is produced by neutrons having a fast spectrum, nominally in excess of 0.1 MeV. The fuel for the LMFBR is primarily fissile plutonium, mixed with depleted uranium, U-238 having a content of fissile U-235 of 0.2 weight percent or less. In addition to the fissile fuel elements in the reactor core, blankets of fertile material are placed both top and bottom and around the periphery of the active core. These fertile blankets can contain additional depleted U-238 or natural thorium Th-232. The term breeder for this reactor type arises from its ability to produce more fissile material than is consumed. This yields a net gain of fissile material from previously non-fissile material with each refueling. The breeder thus permits the utilization of the much more abundant non-fissile isotope U-238, by converting it to fissile plutonium and converting the non-fissile Th-232 to the fissile U-233. This augmentation of the fissile fuel resources extends the potential for producing power from fissile reactions, significantly beyond the time range of any alternative power source now envisioned, except that of the sun or power from the fusion of the hydrogen isotopes.

The function of the LMFBR is twofold:

a. To produce electric power through conversion of fission heat energy to steam and, subsequently through a steam turbine, to electricity, and

b. to produce more fissile material than is consumed in the operation of the reactor.

For this second reason, the LMFBR is intrinsically committed to reprocessing of both fuel and blanket materials, since the recovery of fissile material from these sources is required for continuing operation existence. The data for two of the principal options of the LMFBR type are given in Table 6-27. A schematic flow diagram of these two options is given in Figure 6.5.

The LMFBR fuel cycle permits a number of options, including:

- The fertile U-238 in the blankets can consist of uranium depleted in U-235 to levels produced as "tails" from the enrichment plants or as uranium recovered from reprocessing of LWR spent fuels.
- In addition, thorium can be used as a fertile blanket material (as noted in the preceding paragraphs). This is usually fresh, unirradiated material, but at least in theory, the irradiated Th can be recovered and recycled but a cooling period of about 10 years is needed to insure that some of the more objectionable induced activities have decayed. There is presently no firm plan to use U-233 bred from Th-232 in the LMFBR. The neutronic behavior of Pu (FIS) with fast neutrons, is significantly better in the LMFBR than that of U-233. Conversely, the neutronic behavior of U-233 with thermal neutrons is superior to all other fissile nuclides and insures its use in thermal reactors rather than in breeders.
- The LMFBR operates on a fast neutron spectrum and its efficiency is not compromised by the ingrowth of fission products of high cross-section, but it is not now clear how the fuel reprocessing and separation will be handled. The recovery of plutonium from the core and from the fertile blanket can be carried through to the point where essentially pure plutonium is obtained. There is concern that unadulterated plutonium or other fissile material will somehow find its way into the hands of terrorists or other antisocial groups. There are options in which Pu can be mixed again with the fertile blanket and fission products can be retained rather than removed, thus making the finished fuel elements far more difficult to fabricate and significantly reducing the risk of diversion by sub-national groups for use in nuclear weapons.

The fabrication of fuel using the unspiked mixed oxides of uranium and plutonium is significantly more expensive than for uranium oxide fuel. The deliberate addition of fission products, 'spiking', will further increase costs. Similarly, the reprocessing of spent fuels is complicated if the fission products are not initially removed, as high level waste, from the uranium and plutonium. The option to retain some level of fission product activity in the reprocessing plant product, also requires the use of properly shielded equipment at all points in the processing line. This is compared to a reprocessing flow sheet which removes the high level fission product wastes and delivers essentially clean uranium and plutonium either intermixed or separated from each other.

These options make it difficult to present a consistent figure for:

- the cost of fuel fabrication for plutonium fuels,
- the cost of fuel reprocessing which may include co-processing and spiking, and
- the cost of shipping mixed oxide and spiked fuels.

The technical data, mass flows, and schematic flow diagrams for the LMFBR were provided by Argonne National Laboratory, the Hanford Engineering Development Laboratory and the Department of Energy.

6.5.4.5 The Gas Cooled Fast Breeder Reactor - GCFR

The Gas Cooled Fast Breeder Reactor incorporates features which are common to the HTGR (see paragraph 6.5.4.3) and to the LMFBR (see paragraph 6.5.4.4). The coolant for the GCFR is helium gas at high pressure. The fission reaction depends primarily on fast neutrons. The fuel, which is superficially similar to LMFBR fuel, is designed to be plutonium with blankets of either uranium or thorium. The design characteristics of the GCFR are summarized in Table 6-28. The flow diagram for the GCFR is the same as for the LMFBR and is shown in Figure 6.5. The design data for the GCFR and for its flow sheet were provided by General Atomic Company.

6.5.4.6 General Comments on the Reactor Types Presented

The Light Water Reactors, in both the PWR and BWR designs, are the only reactors commercially deployed in the U.S. today in active service. The Fort St. Vrain high temperature gas cooled reactor is small, 300 MWe, and now appears to be one-of-a-kind. Commercialization of this design is indefinitely postponed. Of the remaining reactor types, reviewed in the preceding paragraphs, the PHWR and the GCFR have not had even prototypes or experimental units built and operated. There is currently no example of the LMFBR in commercial operation in the U.S.

The fuel cycle costs for the LWRs are exemplified by the PWR data. The similarities of the BWR and the PWR to one another are such that the fuel utilization characteristics differ only slightly. The fuel cycle costs, levelized over the 30-year nominal plant lifetimes, do not vary more than ± 10 percent, either way. Consequently, the explicit fuel cycle costs as given for the PWR are applicable to both PWRs and BWRs.

A summary of the 30-year levelized fuel cycle costs are given in Table 6-29 for the reactor types discussed in Section 6.5.4. Both direct and indirect costs are given separately, as well as the total levelized cost, extending over the 30-years of plant operating life beginning in the year noted.
Table 6-30 gives the breakdown of the levelized costs by individual cost component for various options in the fueling mode of the different reactor types. Note that for both tables, the breeder reactor scenarios involving bred fuel and indicated as Scenario 1, are the base cases. See Appendix G for a discussion of the bred fuel scenarios.

The ten (10) base reactors and their fuel cycle 30-year levelized fuel cycle total costs, including direct and indirect costs, are given in Table 6-31.

The fuel cycle costs are functions primarily of the direct market costs of the various cost components which include:

a. Materials

b. Processes

c. Services

As noted previously, to these direct costs are added the indirect costs. The differences in costs reflect the characteristics of the various reactor types coupled with the fuel cycle modes appropriate to each: e.g., throwaway, reprocess and recycle, etc.

The principal fuel cycle cost experience is derived from operations with the LWRs. With the exception of the costs for uranium oxide fuel and enrichment prior to reactor operation, there is very little experience accessible for the remaining reactor fuel cycles. The government's current policy, not to permit reprocessing of LWR fuel, leaves the back-end of the LWR fuel cycle and its costs open to question, since there are no experimental data to support the projections except reprocessing of naval reactor cores and weapons material. The fuel cycle costs presented in this section and in Appendices E-1 through E-4 are, therefore, based as far as possible upon the past history of the light water reactors and the prevailing disposition of the uranium oxide market. All of the values presented here represent points taken in a band of varying costs whose limits are not well defined and whose actual range is uncertain at this time. Despite these shortcomings, which are inherent in the current conditions of nuclear energy in the United States, the costs presented in this study permit an evaluation of:

a. Different reactor types compared to one another.

b. The same spectrum of reactor types compared to other potential sources of electric power generation; in the EEDB this is restricted primarily to coal.

It must be emphasized again that the data on costs permits comparison rather than the establishment of absolute values in the market place. Because of the method used to provide the cost data, it becomes possible to apply escalation factors to the costs at levels selected by the user to suit the individual situation. In Appendices E-1 through E-4, the effects of escalation at six, seven and eight percent on the nuclear fuel cycle costs are presented. Unless it is explicitly stated otherwise, all other costs presented in this review are in terms of constant 1978 dollars, without escalation due to inflation.

6.5.5 Percentage Contribution of Nuclear Fuel Cycle Cost Components

Table 6-32 shows the percentage of the total costs attributable to each cost component. For the thermal neutron spectrum reactors: LWRs, HTGRs, and PHWRs, the uranium supply is the largest single cost. This category includes the U_3O_8, conversion to UF_6 and enrichment to the desired concentration of U-235 (or U-233). For the fast neutron spectrum reactors: LMFBR and GCFR, the uranium supply cost is shown as zero, because the intended fissile fuel is Pu and no value has been assigned to the enrichment processing tails or the depleted uranium recovered in reprocessing, either or both of which constitute the fertile portions of the cores and blankets.

6.6 COAL COSTS

6.6.1 Introduction

Coal costs are needed to assess the economics of coal-fired steam supply systems for central electric generating plants. Coal is a consumable cost item, unlike the nuclear fuels which are treated as quasi-capital investments with depreciation and potential salvage factors. Coal is generally treated as an operational cost, but in this study, to facilitate the economic comparison of nuclear and coal energy sources for production of electricity, the costs of coal are presented as separate items of expense. Nuclear fuels, although basically providing fissile materials, are designed and fabricated to match the reactor operating characteristics. Coal-fired boilers and their adjunct systems, however, are designed to operate on existing, identified coals with generically similar intrinsic characteristics. For economic reasons, the selection and procurement of long-term coal supplies are frequently made concurrently with, and largely determine, the design of the coal-fired steam supply for the generating station.

As a fuel, coal is currently used substantially as it is found in nature. The major expenditures of energy, prior to its use, are its extraction from the ground and its transport to the site where it is to be used. There are relatively minor efforts required to remove extrinsic contaminants and to size the coal for the feed and combustion systems. Environmental protection regulations increasingly require the removal of intrinsic contaminants, especially sulfur, and the control of inherent wastes, to limit the burdens on the local ecosystems. These regulations affect the capital costs and the operational expenses of coal-fired plants, and currently affect directly the costs of coal, only as they impinge on and increase the costs of the extraction processes: underground mining or surface stripping.

The costs of coal are determined principally by:

a. the costs of extraction from the ground; and,
b. the costs of transportation to the site of use.

Coal in the United States varies widely in its characteristics, its accessibility, and its geographic distribution. This variability directly affects the costs to the user. The average calorific value of the coal, its sulfur content, the extraction method dictated by its underground location, and its distance from the user, all diversely affect costs. It is not reasonable to expect, therefore, a single, clearly defined coal price.

The coal-fired systems for which coal costs are presented in this study are limited to those for which capital costs have already been developed. These include the following:

a. Eastern high sulfur coal-fired plant nominal - 1200 MWe
b. Eastern high sulfur coal-fired plant nominal - 800 MWe
c. Western low sulfur coal-fired plant nominal - 1200 MWe
d. Western low sulfur coal-fired plant nominal - 800 MWe
e. Coal gasification combined cycle plant nominal- 600 MWe
f. Coal liquefaction-synfuels - no electricity

The first four plants are conventional coal-fired steam supply system plants; the fifth is a system using the Combustion Engineering coal gasification concept driving gas turbines with the gaseous product, recovering the heat from the turbine discharge in steam generators, and then driving a steam turbine-generator. The coal liquefaction plant converts coal to synthetic liquid fuels but generates no electric power. The systems are described further in Section 5 on capital costs.

6.6.2 Assumptions and Ground-Rules

6.6.2.1 Timing in Coal Cost Estimate

The coal costs for 1978 are stated as of January 1 and, thus, do not include the results of the United Mine Workers (UMW) strike settlement concluded in the first quarter of 1978. For the coal systems, the fuel costs for a plant operating as of January 1, 1978 are representative for that date, but should not be used for the balance of the year or as the basis for future years' projections. The projected coal costs for the year 2001, given in constant 1978 dollars, reflect the effects of the 1978 UMW compensation settlement. Table 6-33 shows the increase in the average delivered contract coal prices for the year 1978. The average costs for the nine months after the 1978 UMW contract settlement show an increase of roughly 20 percent over the average costs for the preceding year, 1977. This step increase is used as the starting point for estimating the coal costs for 2001. The intent of the coal estimate is to provide costs for the year 2001, in terms of constant 1978 dollars.

6.6.2.2 Data Sources Used for Coal Costs

Data for the costs of coal were derived from studies by Electric Power Research Institute, by A. D. Little, by Paul Weir Company, and by United Engineers & Constructors Inc., based on Federal Energy Regulatory Commission information, as referenced in subsection 3.4.2c.

6.6.2.3 Escalation versus Inflation

The estimates include allowance for real increases in costs resulting from such factors as productivity decreases, increased difficulty in mining, and the like, which require larger expenditures of energy/time/manpower. This approach is somewhat pessimistic since it ignores possible increases in productivity, but the pessimism rests on the basis of recent industry experience which showed marked decline in productivity beginning in 1970, as discussed in the EPRI reference document given in subsection 3.4.2c. Inflation, understood as the change in the value of money, is explicitly excluded. The value of escalation for scarcity (e_s) used in these estimates is approximately two percent, based on the A. D. Little and EPRI reference documents given in subsection 3.4.2c.

6.6.2.4 Transportation Costs

Transportation mileage costs, a very large potential contributor to total coal costs, are influenced by whether the coal cars and locomotives are owned by the carrier or by the user/shipper. Further difference in shipping/freight costs are dictated by whether eastern or western railroads are used. In this study, the following assumptions are made:

a. The coal-fired plants are located at the hypothetical "Middletown" site which is described in Appendix A-2.

b. The location of the "Middletown" site is:

  - 2,000 miles from the western low sulfur coal mines
  - 500 miles from the eastern high sulfur coal mines

c. All transportation equipment used belongs to the carrier.

d. Unit trains of 100 cars, at 70 to 100 tons per car, or 7,000 to 10,000 tons per train are used.

e. Mileage costs are computed on western railroad charges for western coals and on eastern railroad charges for eastern coals.

6.6.2.5 Characterization of Coals and Coal-Fired Plants

6.6.2.5.1 Coal Characterization

Two significant characteristics for establishing coal costs are:

a. Impurity content, especially sulfur.

b. Calorific/heating value.

There is a wide variation of both of these factors among coals. A typical eastern high sulfur bituminous coal (Illinois, St. Clair Co., Illinois No. 6) has the analysis shown in Table 6-34. The sulfur content is 3.6 percent and the as-received calorific value is 11,026 Btu/lb (22.05 MBtu/ton). A typical western low sulfur sub-bituminous coal (Wyoming, Campbell Co. 'Roland Smith' Seam) has the analysis shown in Table 6-35. The sulfur content is 0.5 percent and the as-received calorific value is 8,164 Btu/lb (16.292 MBtu/ton). A typical high calorific, eastern high sulfur bituminous coal (Pennsylvania, Washington Co., Pittsburgh No. 8) has the analysis shown in Table 6-36. The sulfur content is 2.6 percent and the as-received calorific value is 13,156 Btu/lb (26.312 MBtu/ton).

Low sulfur content signifies less than 1.0 percent sulfur; greater than 1.0 percent sulfur signifies high sulfur content. The sulfur content, until recently, determined whether sulfur removal was needed to meet the Environmental Protection Agency (EPA) standards. Low sulfur coals did not need the sulfur removal systems. More stringent restrictions on sulfur emissions are anticipated; these will probably increase the coal-fired FPGS capital costs and will be reflected in the next phase of EEDB studies.

As noted in the preceding paragraph, the amount of sulfur in coal has in recent years become the source of concern because of:

a. Purely local air pollution problems, smog formation and health impact.

b. The contribution of SO_2 and NO_x from coal burning systems to the much more general and potentially much more ecologically costly problem of "acid rain."

Reaction of the SO_2 and NO_x with the water in the atmosphere from both sulfur and nitrogen oxides can affect rainfall distribution by providing artificial nucleation centers and can alter the pH of rain and snow, resulting in damage to crops and trees and killing of fish in lakes primarily fed by rain. Adirondack Lakes have changed from around pH 6.5 in 1930 to around pH 4.8 this year. As a direct consequence of this, 90 percent of these lakes no longer support fish life. Thus, the release of acid forming gases from coal-fired plants potentially jeopardizes food and timber supplies as well as vacation areas.

The distinction between high sulfur eastern and low sulfur western coals because of their sulfur content, is underlined by a drastic difference in mine-mouth costs. The eastern coals (east of the Mississippi River) are generally extracted from geologically ancient beds located at considerable depth. Thus, the complexities of underground mining and the need for miners to manipulate cutting, blasting and recovery machines through the relatively restricted seams, leads to high mine-mouth costs. Western coals are usually of lower calorific value, only about 75 percent of eastern coal, so that for the same thermal input requirements for a plant, larger quantities are needed. However, western coals, in addition to having significantly lower sulfur content, are located in relatively younger geological formations near the surface. As a consequence, these coals are more accessible and can generally be strip-mined with very large special machines. Thus, the initial mine-mouth costs are significantly lower, by a factor of around three times, than those of eastern coals. In selecting the "Middletown" site as the location for the hypothetical low sulfur and high sulfur generating stations, a somewhat fictitious burden has been placed on the costs of western coals, since the largest costs are for rail delivery of these coals to a remote site, about 2000 miles from the mine-mouth. Even though the costs of operating on western railroads is somewhat lower than for eastern railroads, the net charge for transportation is high enough to favor eastern coals, as opposed to western coals, in terms of total energy costs. The potential effect of new emission rules is to increase the differential against the use of the western coals in eastern generating plants. This is unfortunate since many coal-fired plants are located in the area east of the Mississippi which contains approximately 75 percent of the total U.S. population. It is clear, however, that for coal-fired generating stations in the western areas in Texas, New Mexico and Arizona, as well as other western states, the western coals have a distinct advantage because of their much lower costs. In addition, the western coals could have significant application for the production of synfuels, especially since the conversion plants may be located at or very close to the mining sites. It is recognized that in such cases the lack of water in large quantities may be a problem.

6.6.2.5.2 Plant Characteristics

The plant characteristics which determine the costs of coal use are the overall station efficiency and net station heat rate. Relevant parameters for the six coal-fired systems are given in Table 4-2. The fuel requirements in tons per hour, reflect the relation of the nominal calorific content of the coals and the plant thermal input needed to produce the station electrical output, where applicable. The coal requirements, thus defined by the Maximum Continuous Rating (MCR), for the system, are combined with the coal unit costs to yield the fuel costs in terms of mills per kilowatt-hour (m/kWh).

6.6.3 Coal Costs

Coal costs are plotted in Figure 6.6. All costs are given in constant 1978 dollars. Inflation is wholly excluded. The imprecision of the plotted data reflect the wide spread of the near-term values. For the later dates, the data are increasingly speculative, but represent the best current estimates.

Coal cost parameters for the five referenced coal-fired FPGS are tabulated in Tables 6-13a, 6-13b and 6-13c.

Particular note should be taken that the Coal Liquefaction station (CLIQ) produces liquefied synthetic fuels and removes the sulfur as part of the preparation for synthesis. The conditions chosen in calculating the fuel costs for CLIQ assume:

- The representative, hypothetical 'Middletown' site;
- Eastern high sulfur coal (Table 6-34);
- 500 mile rail transport on Eastern railroads, in carriers' equipment.

Since no electricity is produced, the power cost, m/kWh, is not applicable for CLIQ.

TABLE 6-1

ENERGY ECONOMIC DATA BASE

FUEL CYCLE COST UPDATE SUMMARY - 2001 STARTUP
(¢/MBtu)(a)

	Nuclear Plant Models						Comparison Plant Models					
Model	BWR	HTGR	PWR	PHWR	GCFR	LMFBR	HS12	HS8	LS12	LS8	CGCC	CLIQ(c)
MWt	3578	3360	3412	3800(b)	2419	3800	3298	2208	3444	2306	1523	*
MWe	1190	1330	1139	1162	917	1390	1232	795	1243	802	630	*
Fuel Cost	63(e)	66(d)	63(d)	28(d)	*	*	170	170	73	73	170	170
Fabrication Cost	8(e)	6	8	8	20	18	*	*	*	*	*	*
Transportation Cost	1(e)	2	1	1	4	4	52	52	222	222	44	52
Disposal Cost	4(e)	2	4	3	21	17	+	+	+	+	+	+
TOTAL	76(e)	76	76	40	45	39	222	222	295	295	214	222

---

* Not Applicable

\+ Disposal Costs for Coal-Fired Plants Are Included in O&M Costs, Section 7

(a) Data in Constant $1978 (Non-Inflated) and Levelized Over 30 Years from 2001

(b) Actual MWt = 3802

(c) 86,800 bbl/d Oil & 36 x 10^6 SCFD Natural Gas

(d) Cost of U_3O_8

(e) Complete BWR Data Are Not Available; Therefore, PWR Data Are Used for BWR (Model A1) Fuel Cycle Costs

Effective Date - 1/1/78

TABLE 6-2

ENERGY ECONOMIC DATA BASE

FUEL CYCLE COST UPDATE SUMMARY - 1978 STARTUP
(¢/MBtu)(a)

	Nuclear Plant Models		Comparison Plant Models			
Model	BWR	PWR	HS12	HS8	LS12	LS8
MWt	3578	3412	3298	2208	3444	2306
MWe	1190	1139	1232	795	1243	802
Fuel Cost	57(b)	57	104	104	49	49
Fabrication Cost	8(b)	8	*	*	*	*
Transportation Cost	1(b)	1	38	38	159	159
Disposal Cost	4(b)	4	+	+	+	+
TOTAL	70(b)	70	142	142	208	208

---

* Not Applicable

\+ Disposal Costs for Coal-Fired Plants Are Included in O&M Costs, Section 7

(a) Data in Constant $1978 (Non-Inflated) and Levelized Over 30 Years From 1978

(b) Complete BWR Data Are Not Available; Therefore, PWR Data Are Used for BWR (Model A1) Fuel Cycle Costs

TABLE 6-3

ENERGY ECONOMIC DATA BASE

FUEL CYCLE COST UPDATE SUMMARY - VARIABLE STARTUP (¢/MBtu)(a)

	Nuclear Plant Models				Coal Plant Model
Model	BWR(b)	HTGR(c)	PWR(b)	PHWR(c)	CGCC(b)
MWt	3578	3360	3412	3800(d)	1520
MWe	1190	1330	1139	1162	630
Fuel Cost	59(e)	65	59	28	126
Fabrication Cost	8(e)	6	8	8	*
Transportation Cost	1(e)	2	1	1	36
Disposal Cost	4(e)	2	4	3	+
TOTAL	72(e)	75	72	40	162

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* Not Applicable

\+ Disposal Costs for Coal-Fired Plants Are Included in O&M Costs, Section 7

(a) Data in Constant $1978 (Non-Inflated) and Levelized Over 30 Years from Date of Startup

(b) 1987 Startup

(c) 1995 Startup

(d) Actual MWt = 3802

(e) Complete BWR Data Are Not Available; Therefore, PWR Data Are Used for BWR (Model A1) Fuel Cycle Costs

Effective Date: January 1, 1978
(1) System : PWR-U5(LE)/U-T
Start Up : January 1, 1978
Bred Fuel Scenario: N/A

TABLE 6-4a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1978	1983	1988	1993	1998	2003	2008	2013
.10	Initial Fuel Loaded	$/KgH								
.11	Uranium Supply	$/KgU								
.111	U_3O_8 Supply	$/lb U_3O_8	40	43.5	54	59	61	63	64	64
.112	UF_6 Conversion Services	$/KgU as UF_6	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	$/KgH								
.20	Fabrication	$/KgH	177	177	177	177	177	177	177	177
.21	Core Fabrication	$/KgH								
.22	Axial Blanket Fabrication	$/KgH								
.23	Radial Blanket Fabrication	$/KgH								
.30	Shipping to Temporary Storage	$/KgH								
.40	Temporary Storage	$/KgH								
.50	Shipping to Repository	$/KgH	18	18	16	16	16	16	16	16
.60	Disposal of Spent Fuel	$/KgH	134	134	134	134	134	134	134	134

(1) See Table 6-21 for System Codes

Effective Date: January 1, 1978
(1) System : PWR-U5(LE)/U-T
Start Up : January 1, 1978
Bred Fuel Scenario: N/A

TABLE 6-4b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

		OUTPUT QUANTITIES, $/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR(2) LEVELIZED
Account No.	Account Description	1	5	10	15	20	25	30	TOTAL $/MBtu
.00	Total	0.63	0.58	0.59	0.65	0.66	0.67	0.67	0.70
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.43	0.46	0.47	0.53	0.54	0.55	0.55	0.57
.111	U_3O_8 Supply								
.112	UF_6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.12	0.07	0.07	0.07	0.07	0.07	0.07	0.08
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
.60	Disposal of Spent Fuel	0.07	0.04	0.04	0.04	0.04	0.04	0.04	0.04

(1) See Table 6-21 for System Codes.
(2) The column for the 30-year levelized costs include indirect costs; the other columns do not.

Effective Date: January 1, 1978
(1) System : PWR-U5(LE)/U-T
Start Up : January 1, 1987
Bred Fuel Scenario: N/A

TABLE 6-5a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

			INPUT QUANTITIES BY CALENDAR YEAR							
Account No.	Account Description	Units	1985	1990	1995	2000	2005	2010	2015	2020
.10	Initial Fuel Loaded	$/KgH								
.11	Uranium Supply	$/KgU								
.111	U_3O_8 Supply	$/lb U_3O_8	45	56	60	62	63	64	65	66
.112	UF_6 Conversion Services	$/KgU as UF_6	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	$/KgH								
.20	Fabrication	$/KgH	177	177	177	177	177	177	177	177
.21	Cote Fabrication	$/KgH								
.22	Axial Blanket Fabrication	$/KgH								
.23	Radial Blanket Fabrication	$/KgH								
.30	Shipping to Temporary Storage	$/KgH								
.40	Temporary Storage	$/KgH								
.50	Shipping to Repository	$/KgH	18	18	16	16	16	16	16	16
.60	Disposal of Spent Fuel	$/KgH	134	134	134	134	134	134	134	134

(1) See Table 6-21 for System Codes

Effective Date: January 1, 1978
(1) System : PWR-U5(LE)/U-T
Start Up : January 1, 1987
Bred Fuel Scenario: N/A

TABLE 6-5b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Account No.	Account Description	OUTPUT QUANTITIES, $/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR (2) LEVELIZED TOTAL $/MBtu
		1	5	10	15	20	25	30	
.00	Total	0.67	0.62	0.65	0.67	0.67	0.68	0.68	0.72
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.47	0.50	0.53	0.55	0.55	0.56	0.56	0.59
.111	U_3O_8 Supply								
.112	UF_6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.12	0.07	0.07	0.07	0.07	0.07	0.07	0.08
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
.60	Disposal of Spent Fuel	0.07	0.04	0.04	0.04	0.04	0.04	0.04	0.04

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(1) See Table 6-21 for System Codes.
(2) The column for the 30-year levelized costs include indirect costs; the other columns do not.

TABLE 6-6a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
(1) **System** : PWR-U5(LE)/U-T
Start Up : January 1, 2001
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	$/KgH								
.11	Uranium Supply	$/KgU								
.111	U_3O_8 Supply	$/lb U_3O_8	62	63	64	65	66	67	67	68
.112	UF_6 Conversion Services	$/KgU as UF_6	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	$/KgH								
.20	Fabrication	$/KgH	177	177	177	177	177	177	177	177
.21	Core Fabrication	$/KgH								
.22	Axial Blanket Fabrication	$/KgH								
.23	Radial Blanket Fabrication	$/KgH								
.30	Shipping to Temporary Storage	$/KgH								
.40	Temporary Storage	$/KgH								
.50	Shipping to Repository	$/KgH	16	16	16	16	16	16	16	16
.60	Disposal of Spent Fuel	$/KgH	134	134	134	134	134	134	134	134

(1) See Table 6-21 for System Codes

Effective Date: January 1, 1978
(1) System : PWR-U5(LE)/U-T
Start Up : January 1, 2001
Bred Fuel Scenario: N/A

TABLE 6-6b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Account No.	Account Description	OUTPUT QUANTITIES, $/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR (2) LEVELIZED TOTAL $/MBtu
		1	5	10	15	20	25	30	
.00	Total	0.76	0.67	0.68	0.68	0.69	0.70	0.70	0.76
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.56	0.55	0.56	0.56	0.57	0.58	0.58	0.63
.111	U_3O_8 Supply								
.112	UF_6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.12	0.07	0.07	0.07	0.07	0.07	0.07	0.08
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
.60	Disposal of Spent Fuel	0.07	0.04	0.04	0.04	0.04	0.04	0.04	0.04

(1) See Table 6-21 for System Codes.
(2) The column for the 30-year levelized costs include indirect costs; the other columns do not.

Effective Date: January 1, 1978
(2) System : HTGR-U5/U/Th-20%-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

TABLE 6-7a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR 1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	$/KgH								
.11	Uranium Supply	$/KgU								
.111	U_3O_8 Supply	$/lb U_3O_8	56	60	62	63	64	65	66	67
.112	UF_6 Conversion Services	$/KgU as UF_6	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	$/KgH								
.20	Fabrication	$/KgH	365	488	488	488	488	488	488	488
.21	Core Fabrication	$/KgH								
.22	Axial Blanket Fabrication	$/KgH								
.23	Radial Blanket Fabrication	$/KgH								
.30	Shipping to Temporary Storage	$/KgH								
.40	Temporary Storage	$/KgH								
.50	Shipping to Repository	$/KgH	180/250(1) →							
.60	Disposal of Spent Fuel	$/KgH	370	370	370	370	370	370	370	370

(1) Initial Core Fuel/Reload Fuel
(2) See Table 6-21 for System Codes

Effective Date: January 1, 1978
(1) System : HTGR-U5/U/Th-20%-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

TABLE 6-7b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

		OUTPUT QUANTITIES, $/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL $/MBtu (2)
Account No.	Account Description	1	5	10	15	20	25	30	
.00	Total	0.91	0.63	0.65	0.65	0.66	0.66	0.67	0.75
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.69	0.54	0.56	0.56	0.57	0.57	0.58	0.65
.111	U_3O_8 Supply								
.112	UF_6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.10	0.05	0.05	0.05	0.05	0.05	0.05	0.06
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02
.60	Disposal of Spent Fuel	0.08	0.02	0.02	0.02	0.02	0.02	0.02	0.02

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(1) See Table 6-21 for System Codes.
(2) The column for the 30-year levelized costs include indirect costs; the other columns do not.

TABLE 6-8a

ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
(2) System : HTGR-U5/U/Th-20%-T
Start Up : January 1, 2001
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR 2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	$/KgH								
.11	Uranium Supply	$/KgU								
.111	U_3O_8 Supply	$/lb U_3O_8	62	63	64	65	66	67	67	68
.112	UF_6 Conversion Services	$/KgU as UF_6	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	$/KgH								
.20	Fabrication	$/KgH	365	488	488	488	488	488	488	488
.21	Core Fabrication	$/KgH								
.22	Axial Blanket Fabrication	$/KgH								
.23	Radial Blanket Fabrication	$/KgH								
.30	Shipping to Temporary Storage	$/KgH								
.40	Temporary Storage	$/KgH								
.50	Shipping to Repository	$/KgH	180/250(1) →							→
.60	Disposal of Spent Fuel	$/KgH	370	370	370	370	370	370	370	370

(1) Initial Core Fuel/Reload Fuel
(2) See Table 6-21 for System Code

Effective Date: January 1, 1978
(1) System : HTGR-U5/U/Th-20%-T
Start Up : January 1, 2001
Bred Fuel Scenario: N/A

TABLE 6-8b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

		OUTPUT QUANTITIES, $/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED (2)
Account No.	Account Description	1	5	10	15	20	25	30	TOTAL $/MBtu
.00	Total	0.93	0.64	0.66	0.66	0.66	0.67	0.67	0.76
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.71	0.55	0.57	0.57	0.57	0.58	0.58	0.66
.111	U_3O_8 Supply								
.112	UF_6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.10	0.05	0.05	0.05	0.05	0.05	0.05	0.06
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02
.60	Disposal of Spent Fuel	0.08	0.02	0.02	0.02	0.02	0.02	0.02	0.02

(1) See Table 6-21 for System Code.
(2) The column for the 30-year levelized costs include indirect costs; the other columns do not.

TABLE 6-9a

ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
(1) System : PHWR-U5(SE)/U-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	$/KgH								
.11	Uranium Supply	$/KgU								
.111	U_3O_8 Supply	$/lb U_3O_8	56	60	62	63	64	65	66	67
.112	UF_6 Conversion Services	$/KgU as UF_6	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	$/KgH								
.20	Fabrication	$/KgH	104	104	104	104	104	104	104	104
.21	Core Fabrication	$/KgH								
.22	Axial Blanket Fabrication	$/KgH								
.23	Radial Blanket Fabrication	$/KgH								
.30	Shipping to Temporary Storage	$/KgH								
.40	Temporary Storage	$/KgH								
.50	Shipping to Repository	$/KgH	13	12	12	12	12	12	12	12
.60	Disposal of Spent Fuel	$/KgH	83	83	83	83	83	83	83	83

(1) See Table 6-21 for System Code

Effective Date: January 1, 1978
(1) System : PHWR-U5(SE)/U-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

TABLE 6-9b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

		OUTPUT QUANTITIES, $/MBtu							
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR (2) LEVELIZED TOTAL $/MBtu
Account No.	Account Description	1	5	10	15	20	25	30	
.00	Total	0.59	0.35	0.36	0.36	0.37	0.37	0.37	0.40
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.30	0.25	0.25	0.25	0.26	0.26	0.26	0.28
.111	U_3O_8 Supply								
.112	UF_6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.18	0.06	0.06	0.06	0.06	0.06	0.06	0.08
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
.60	Disposal of Spent Fuel	0.10	0.03	0.04	0.04	0.04	0.04	0.04	0.03

(1) See Table 6-21 for System Code.
(2) The column for the 30-year levelized costs include indirect costs; the other columns do not.

Effective Date: January 1, 1978
(1) System : PHWR U5(SE)/U-T
Start Up : January 1, 2001
Bred Fuel Scenario: N/A

TABLE 6-10a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U_3O_8 Supply	\$/lb U_3O_8	62	63	64	65	66	67	67	68
.112	UF_6 Conversion Services	\$/KgU as UF_6	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	104	104	104	104	104	104	104	104
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	12	12	12	12	12	12	12	12
.60	Disposal of Spent Fuel	\$/KgH	83	83	83	83	83	83	83	83

(1) See Table 6-21 for System Code

Effective Date: January 1, 1978
(1) System : PHWR-U5(SE)/U-T
Start Up : January 1, 2001
Bred Fuel Scenario: N/A

TABLE 6-10b

ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

		OUTPUT QUANTITIES, $/MBtu							30-YEAR[2]
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							LEVELIZED
Account No.	Account Description	1	5	10	15	20	25	30	TOTAL $/MBtu
.00	Total	0.60	0.35	0.36	0.36	0.37	0.37	0.37	0.40
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.31	0.25	0.25	0.25	0.26	0.26	0.26	0.28
.111	U_3O_8 Supply								
.112	UF_6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.18	0.06	0.06	0.06	0.06	0.06	0.06	0.08
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
.60	Disposal of Spent Fuel	0.10	0.03	0.04	0.04	0.04	0.04	0.04	0.03

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(1) See Table 6-21 for System Code.
(2) The column for the 30-year levelized costs include indirect costs; the other columns do not.

Effective Date: January 1, 1978
(1) System : GCFR-Pu/U/U/U
Start Up : January 1, 2001
(2) Bred Fuel Scenario: 1

TABLE 6-11a

ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U_3O_8 Supply	\$/lb U_3O_8								
.112	UF_6 Conversion Services	\$/KgU as UF_6								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	842	842	842	842	842	842	842	842
.22	Axial Blanket Fabrication	\$/KgH	49	49	49	49	49	49	49	49
.23	Radial Blanket Fabrication	\$/KgH	177	177	177	177	177	177	177	177
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	94	94	94	94	94	94	94	94
.60	Reprocessing	\$/KgH	370	326	271	260	260	260	260	260
.70	Disposal of Reprocessing Wastes	\$/KgH	194	194	194	194	194	194	194	194
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U_3O_8 Supply	\$/lb U_3O_8								
.812	Equivalent UF_6 Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH								

(1) See Table 6-21 for System Code
(2) See Appendix G for Fuel Scenario Description

TABLE 6-11b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
(6) System : GCFR-Pu/U/U/U
Start Up : January 1, 2001
(7) Bred Fuel Scenario: 1

Account No.	Account Description	OUTPUT QUANTITIES, $/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR 1	5	10	15	20	25	30	30-YEAR (5) LEVELIZED TOTAL $/MBtu
.00	Total	0.95	0.44	0.42	0.42	0.42	0.42	0.42	0.45
.10	Initial Fuel Loaded								
.11	Uranium Supply(1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U_3O_8 Supply								
.112	UF_6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply(2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.31	0.16	0.16	0.16	0.16	0.16	0.16	0.20(4)
.21	Core Fabrication	0.20	0.11	0.11	0.11	0.11	0.11	0.11	
.22	Axial Blanket Fabrication	0.02	0.01	0.01	0.01	0.01	0.01	0.01	
.23	Radial Blanket Fabrication	0.09	0.04	0.04	0.04	0.04	0.04	0.04	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04
.60	Reprocessing }	0.54	0.24	0.22	0.22	0.22	0.22	0.22	0.21
.70	Disposal of Reprocessing Wastes }								
.80	Final Fuel Recovered (Credits)								
.81	Uranium(1)								
.811	Equivalent U_3O_8 Supply								
.812	Equivalent UF_6 Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium(2)								
.83	Bred U-233								
.90	Refabrication of Recovered Fuel								

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(1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.

(2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.

(3) Not used.

(4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23)

(5) The column for the 30-year levelized costs include indirect costs; the other columns do not.

(6) See Table 6-21 for System Code.

(7) See Appendix G for Fuel Scenario Description.

Effective Date: January 1, 1978
(1) System : LMFBR-Pu/U/U/U-HT
Start Up : January 1, 2001
(2) Bred Fuel Scenario: 1

TABLE 6-12a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR 2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	$/KgH								
.11	Uranium Supply	$/KgU								
.111	U_3O_8 Supply	$/lb U_3O_8								
.112	UF_6 Conversion Services	$/KgU as UF_6								
.113	Enrichment Services	$/SWU								
.114	Depleted U Supply	$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	$/KgH								
.20	Fabrication	$/KgH								
.21	Core Fabrication	$/KgH	769	769	769	769	769	769	769	769
.22	Axial Blanket Fabrication	$/KgH	49	49	49	49	49	49	49	49
.23	Radial Blanket Fabrication	$/KgH	177	177	177	177	177	177	177	177
.30	Shipping to Temporary Storage	$/KgH								
.40	Temporary Storage	$/KgH								
.50	Shipping to Reprocessor	$/KgH	94	94	94	94	94	94	94	94
.60	Reprocessing	$/KgH	370	326	271	260	260	260	260	260
.70	Disposal of Reprocessing Wastes	$/KgH	194	194	194	194	194	194	194	194
.80	Final Fuel Recovered (Credits)	$/KgH								
.81	Uranium	$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U_3O_8 Supply	$/lb U_3O_8								
.812	Equivalent UF_6 Conversion Services	$/KgU								
.813	Equivalent Enrichment Services	$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	$/KgH								

(1) See Table 6-21 for System Code
(2) See Appendix G for Scenario Description

TABLE 6-12b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
(5) System : LMFBR-Pu/U/U/U-HT
Start Up : January 1, 2001
(6) Bred Fuel Scenario: 1

		OUTPUT QUANTITIES, $/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR (7) LEVELIZED
Account No.	Account Description	1	5	10	15	20	25	30	TOTAL $/MBtu
.00	Total	0.69	0.38	0.36	0.36	0.36	0.36	0.36	0.39
.10	Initial Fuel Loaded								
.11	Uranium Supply(1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U_3O_8 Supply								
.112	UF_6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply(2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.26	0.16	0.16	0.16	0.16	0.16	0.16	0.18(4)
.21	Core Fabrication	0.20	0.13	0.13	0.13	0.13	0.13	0.13	
.22	Axial Blanket Fabrication	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
.23	Radial Blanket Fabrication	0.05	0.02	0.02	0.02	0.02	0.02	0.02	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.07	0.03	0.03	0.03	0.03	0.03	0.03	0.04
.60	Reprocessing }	0.36	0.19	0.17	0.17	0.17	0.17	0.17	0.17
.70	Disposal of Reprocessing Wastes }								
.80	Final Fuel Recovered (Credits)								
.81	Uranium(1)								
.811	Equivalent U_3O_8 Supply								
.812	Equivalent UF_6 Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium(2)								
.83	Bred U-233								
.90	Refabrication of Recovered Fuel								

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(1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.

(2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.

(3) Not used.

(4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23).

(5) See Table 6-21 for System Code.

(6) See Appendix G for Fuel Scenario Description

(7) The column for the 30-year levelized costs include indirect costs; the other columns do not.

Effective Date: January 1, 1978
System : Coal-Fired FPGS(5)
Startup : January 1, 1978

TABLE 6-13a
ENERGY ECONOMIC DATA BASE
COAL FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Plant Type		Coal	Coal Costs(1)		Transportation Costs(2)				Total
Model	MWe	Type(3)	$/ton	$/MBtu	$/t-mi(4)	Miles	$/ton	$/MBtu	$/MBtu
HS12	1232	EHS	22.85	1.04	0.017	500	8.50	0.38	1.42
HS8	795								
LS12	1243	WLS	7.90	0.49	0.013	2000	26.00	1.59	2.08
LS8	802								

(1) Coal Costs are FOB Mine Mouth
(2) Transportation Costs are "Delivered to User"
(3) EHS = Eastern (High Sulfur) Coal; WLS = Western (Low Sulfur) Coal. Refer to Tables 6-34 and 6-35 for Coal Constituents
(4) $/t-mi = $ per ton-mile
(5) FPGS = Fossil Power Generating Station

Effective Date: January 1, 1978
System : Coal-Fired FPGS(5)
Startup : January 1, 1987

TABLE 6-13b
ENERGY ECONOMIC DATA BASE
COAL FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Plant Type		Coal	Coal Costs(1)		Transportation Costs(2)				Total
Model	MWe	Type(3)	$/ton	$/MBtu	$/t-mi(4)	Miles	$/ton	$/MBtu	$/MBtu
HS12	1232	EHS	27.80	1.26	0.019	500	9.50	0.44	1.70
HS8	795								
CLIQ	*								
LS12	1243	WLS	9.30	0.58	0.015	2000	30.00	1.86	2.44
LS8	802								
CGCC	630	PHS	34.00	1.26	0.019	500	9.50	0.36	1.62

* Not Applicable
(1) Coal Costs are FOB Mine Mouth
(2) Transportation Costs are "Delivered to User"
(3) EHS = Eastern (High Sulfur) Coal; WLS = Western (Low Sulfur) Coal; PHS = Pittsburgh Steam (High Sulfur) Coal. Refer to Tables 6-34, 6-35 and 6-36, for Coal Constituents
(4) $/t-mi = $ per ton-mile
(5) FPGS = Fossil Power Generating Station

Effective Date: January 1, 1978
System : Coal-Fired FPGS(5)
Startup : January 1, 2001

Table 6-13c
ENERGY ECONOMIC DATA BASE
COAL FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Plant Type		Coal	Coal Costs(1)		Transportation Costs(2)				Total
Model	MWe	Type(3)	$/ton	$/MBtu	$/t-mi(4)	Miles	$/ton	$/MBtu	$/MBtu
HS12	1232	EHS	37.40	1.70	0.023	500	11.50	0.52	2.22
HS8	795								
CLIQ	*								
LS12	1243	WLS	11.95	0.73	0.018	2000	36.00	2.22	2.95
LS8	802								
CGCC	630	PHS	46.10	1.70	0.023	500	11.50	0.44	2.14

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* Not Applicable

(1) Coal Costs are FOB Mine-Mouth

(2) Transportation Costs are "Delivered to User"

(3) EHS = Eastern (High Sulfur) Coal; WLS = Western (Low Sulfur) Coal; PHS = Pittsburgh Steam (High Sulfur) Coal. Refer to Tables 6-34, 6-35 and 6-36, for Coal Constituents

(4) $/t-mi = $ per ton-mile

(5) FPGS = Fossil Power Generating Station

TABLE 6-14
ENERGY ECONOMIC DATA BASE
SUMMARY OF FUEL CYCLE UNIT PRICES
(January 1978 Dollars)

Natural Uranium ($/lb U_3O_8)	45 (in 1985) - 62 (in 2000)
Conversion to UF_6 ($/KgU)	4.7
Enrichment ($/SWU)	91

	PWR	HTGR	PHWR	LMFBR	GCFR
Fabrication ($/KgHM)	177(1)	469(2)	104	769(3)(4)	842(3)(4)
Spent Fuel Shipping ($/KgHM)	20	250	12	94	94
Reprocessing ($/KgHM)	280(5)	720(6)	-	370(7)	370(7)
High Level Waste Disposal ($/KgHM)	62	117	-	194	194
Spent Fuel Disposal ($/KgHM)	134	370	83	-	-

---

(1) Fabrication of UO_2 fuel. For PuO_2-UO_2 fuel, $486/KgHM.

(2) Fabrication of makeup reload fuel ($2620/block). For recycle fuel, $1413/KgHM ($7894/block), all estimated on the basis of $/block.

(3) Fabrication of core fuel.

(4) Fabrication of blankets: Axial - U = $49/kgU; Th = $79/kgHM; Radial - U = $177/kgU; Th = $207/kgHM.

(5) Reprocessing in 1991, decreasing to $200/KgHM in 2001.

(6) For reload fuel based on estimated reprocessing cost of $4035/block.

(7) Reprocessing in 2001, decreasing to $260/KgHM in 2011.

TABLE 6-15
ENERGY ECONOMIC DATA BASE
PROJECTED U_3O_8 COSTS
(January 1978 Dollars)

Year	\$/lb U_3O_8
1985	45
1986	49
1987	52
1988	54
1989	55
1990	56
1991	57
1992	58
1993	59
1994	59
1995	60
1996	60
1997	61
1998	61
1999	62
2000	62
2002	62
2004	63
2006	63
2008	64
2010	64
2015	65
2020	66
2025	67
2030	67
2035	68

Effective Date - 1/1/78

TABLE 6-16

ENERGY ECONOMIC DATA BASE
PROJECTED FUEL FABRICATION COSTS
(January 1978 Dollars)

Reactor/Fuel Type		$/KgHM
PWR		
	UO_2 Fuel	177
	PuO_2-UO_2 Fuel	486
PHWR	UO_2 (Slightly Enriched)	104
HTGR		
	Fresh Fuel (Initial/Make-up)	337/469*
	Recycle Fuel	1413**
LMFBR		
	Core	769
	Uranium Blanket - Axial	49
	Uranium Blanket - Radial	177
	Thorium Blanket - Axial	79
	Thorium Blanket - Radial	207
GCFR		
	Core	842
	Uranium Blanket - Axial	49
	Uranium Blanket - Radial	177
	Thorium Blanket - Axial	79
	Thorium Blanket - Radial	207

---

* Based on estimated fabrication cost of $2620/block.
** Based on estimated fabrication cost of $7894/block.

TABLE 6-17

ENERGY ECONOMIC DATA BASE

PROJECTED SPENT FUEL SHIPPING COSTS
(January 1978 Dollars)

Reactor/Fuel Type	$/KgHM 1985-1994	 Beyond 1995
PWR, UO_2 Fuel	18	16
PWR, PuO_2-UO_2 Fuel	22	20
PHWR, UO_2 (Slightly Enriched)	13	12
HTGR (Initial/Reload)	180/250*	180/250*
LMFBR	N/A	94
GCFR	N/A	94

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* Based on estimated shipping cost of $1390/block.

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TABLE 6-18

ENERGY ECONOMIC DATA BASE

PROJECTED REPROCESSING COSTS
(January 1978 Dollars)

PWR		LMFBR and GCFR		HTGR	
Year	$/KgHM	Year	$/KgHM	Year	$/KgHM
1991	280	2001	370	1995 on	519/720*
1992	272	2002	359		
1993	264	2003	348		
1994	256	2004	337		
1995	248	2005	326		
1996	240	2006	315		
1997	232	2007	304		
1998	224	2008	293		
1999	216	2009	282		
2000	208	2010	271		
2001 on	200	2011 on	260		

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* Initial/reload based on estimated reprocessing cost of $4035/block.

TABLE 6-19 Effective Date - 1/1/78

ENERGY ECONOMIC DATA BASE

SUMMARY OF FUEL CYCLE LEAD AND LAG TIMES
(In Quarter-Years)

Lead Time (to reactor startup date)	PWR	HTGR	PHWR (f)	FBR
1. Payment for U_3O_8 purchased				
Initial core	7	7	5/5	(g)
Reloads	4	4	2/4	(g)
2. Payment for Plutonium purchased				
Initial core	--	--	--	5
Reloads	(a)	--	--	(h)
3. Payment for Conversion Services				
Initial core	5.667	5.667	-/-	--
Reloads	2.667	2.667	-/2.667	--
4. Payment for Enrichment Services				
Initial core	5	5	-/-	--
Reloads	2	2	-/2	--
5. Payment for Fabrication				
Initial core	2	2(d)	2/2	2
Reloads	1	1(d)	1/1	1
Lag Time (from discharge date from reactor)				
6. Payment for Spent Fuel Shipping	2/20(b)	2/20(b)	40/40	2
7. Payment for Reprocessing Services	2	2	--	2
8. Payment for Waste Disposal	2	2	--	--
9. Payment for Spent Fuel Disposal	20	20	40/40	--
10. Receipt of Credit for Uranium Recovered	3(c)	2(e)	--	3
11. Receipt of Credit for Plutonium Recovered	3(a)	--	--	3(h)

TABLE 6-19 (cont.)

ENERGY ECONOMIC DATA BASE

SUMMARY OF FUEL CYCLE LEAD AND LAG TTMES
(In Quarter-Years)

(a) For recycle alternative, recovered plutonium will be recycled to the subsequent cycles with a lag time of 2 cycle lengths (self-generated mode).

(b) Recycle alternative/throwaway alternative.

(c) For recycle alternative, recovered uranium will be recycled to the subsequent cycles with a lag time of 2 cycle lengths (self-generated mode).

(d) Fabrication costs include material cost for THO_2.

(e) For recycle alternative, recovered uranium will be recycled to the subsequent cycles with a lag time of 1 cycle length (self-generated mode), based on GAC mass flows.

(f) Natural uranium fuel cycle/slightly enriched uranium fuel cycle; (CANDU).

(g) It is assumed that makeup uranium is depleted uranium whose value is zero.

(h) Recovered plutonium will be recycled to the subsequent cycles with a lag time of 2 cycle lengths. Net plutonium gained or added will be sold at the lag time, or purchased at the lead time, respectively.

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TABLE 6-20

ENERGY ECONOMIC DATA BASE

REACTOR TYPES, CYCLE, RATING, AND START-UP DATE

REACTOR TYPE AND CYCLE	NASAP (1) CYCLE DESIGNATION	NOMINAL (2) THERMAL RATING (MWt)	START-UP DATE 1 JANUARY + YEAR
LWR (Throwaway)	U5(LE)/U-T	3800	1987
LWR (Pu Recycle)	U5(LE) + Pu(RE)/U	3800	1991
HTGR (Throwaway)	U5/U/Th-20%-T	3360	1995
HTGR (^{233}U Recycle)	U5(DE)/U/Th-20%	3360	1995
PHWR (Throwaway) (CANDU - NAT. U)	U5(NAT)/U-T	3990	1995
PHWR (Throwaway) (CANDU - Slightly Enriched - 1.2%)	U5(SE)/U-T	3990	1995
LMFBR (U Blanket)	Pu/U/U/U-HT	3318	2001
LMFBR (Th Blanket)	Pu/U/Th/Th-HT	3411	2001
GCFR (U Blanket)	Pu/U/U/U	3290	2001
GCFR (Th Blanket)	Pu/U/Th/Th	3290	2001

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(1) Nonproliferation Alternate Systems Assessment Program.

(2) The nominal thermal ratings may not agree with the actual thermal ratings used elsewhere in this report.

TABLE 6-21

ENERGY ECONOMIC DATA BASE

BASIC FEATURES OF BASELINE REACTOR/FUEL CYCLE SYSTEMS

System Designation	Reactor Type	Fuel Type	Fuel Cycle Alternative	Reactor Thermal Output (MWt)	Reactor Start Date
PWR-U5(LE)/U-T	LWR(PWR)	low-enriched uranium (UO_2)	throwaway	3800	Jan. 1, 1987
PWR-U5(LE)+ Pu(RE)/U	LWR(PWR)	low-enriched uranium and plutonium oxide (UO_2 - PuO_2)	recycle of plutonium and uranium (self-generated)	3800	Jan. 1, 1991
HTGR-U5/U/Th-20%-T	HTGR	medium-enriched uranium (20%) and thorium (UC_2-ThO_2)	throwaway	3360	Jan. 1, 1995
HTGR-U5(DE)/U/Th-20%	HTGR	medium-enriched uranium (denatured 20%) and thorium (UC_2-ThO_2)	recycle of U-233 (self-generated)	3360	Jan. 1, 1995
PHWR-U5(NAT)/U-T (CANDU)	PHWR	natural uranium (UO_2)	throwaway	3990	Jan. 1, 1995
PHWR-U5(SE)/U-T (CANDU)	PHWR	slightly-enriched (1.2%) uranium (UO_2)	throwaway	3990	Jan. 1, 1995
LMFBR-Pu/U/U/U-HT	LMFBR	Pu/depleted uranium-core, and depleted uranium-blankets (PuO_2-UO_2/UO_2/UO_2)	recycle of plutonium in breeders	3318	Jan. 1, 2001
LMFBR-Pu/U/Th/Th-HT	LMFBR	Pu/depleted uranium-core, and thorium blankets (PuO_2-UO_2/ThO_2/ThO_2)	recycle of plutonium in breeders, recycle of U-233 in converters	3411	Jan. 1, 2001
GCFR-Pu/U/U/U	GCFR	Pu/depleted uranium-core, and depleted uranium blankets (PuO_2-UO_2/UO_2/UO_2)	recycle of plutonium in breeders	3290	Jan. 1, 2001
GCFR-Pu/U/Th/Th	GCFR	Pu/depleted uranium-core, and thorium-blankets (PuO_2-UO_2/ThO_2/ThO_2)	recycle of plutonium in breeders, recycle of U-233 in converters	3290	Jan. 1, 2001

TABLE 6-22
ENERGY ECONOMIC DATA BASE
DESIGN CHARACTERISTICS OF PWR

	PWR-U5(LE)/U-T Disposal	PWR-U5(LE)+Pu(RE)/U Recycle
Reactor Thermal Output	3,800 MWt	3,800 MWt
Number of Fuel Assemblies	241	241
Fuel Type	Oxide Fuel (UO_2)	Oxide Fuel (UO_2/PuO_2-UO_2)
Approximate Fraction of Core Replaced at Each Refueling	1/3	1/3
Start of Plutonium Recycle	N/A	Cycle 4
Initial Core (Average)		
Discharge Burnup	21,082 MWD/MTU	21,077 MWD/MTU
Core Loading	99.313 MTU	99.313 MTU
Fresh Fuel Enrichment	2.22 w/o U-235	2.22 w/o U-235
Spent Fuel Enrichment	0.73 w/o U-235	0.73 w/o U-235
Fissile Plutonium Discharged	5.427 Kg/MTU_i	5.246 Kg/MTU_i
Replacement Loadings		
Discharge Burnup	30,360 MWD/MTU	30,360 MWD/MTH
Core Loading	102.783 MTU	102.782 MTH
Fresh Fuel Enrichment	3.01 w/o U-235	3.30 w/o(*)
Fissile Plutonium Charged	---	9.807 Kg/MTH_i
Spent Fuel Enrichment	0.85 w/o U-235	0.76 w/o U-235(**)
Fissile Plutonium Discharged	6.596 Kg/MTU_i	10.887 Kg/MTH_i

(*) Mixture of 3.20 w/o U-235 (22319 Kg), natural uranium (11387 Kg), and 336 Kg of fissile plutonium, per batch.

(**) Mixture of 0.95 w/o U-235 (21627 Kg) and 0.39 w/o U-235 (11154 Kg), per batch.

TABLE 6-23

ENERGY ECONOMIC DATA BASE
DESIGN CHARACTERISTICS OF BWR(1)

	Disposal	Recycle
Reactor Thermal Output	3,579 MWt	3,579 MWt
Number of Fuel Assemblies	748	752
Fuel Type	Oxide Fuel (UO_2)	Mixed Oxide Fuel (UO_2+PuO_2)
Approximate Fraction of Core Replaced at Each Refueling	0.25	0.25
Start of Plutonium Recycle	N/A	Cycle 5
Initial Core (Average)		
Discharge Burnup	17,500 MWD/MTU	21,211 MWD/MTHM
Core Loading	136.136 MTU	136.907 MTHM
Fresh Fuel Enrichment	1.9 w/o ^{235}U	2.16 w/o ^{235}U
Fissile Plutonium Loaded	N/A	0.35 w/o ^{FIS}Pu (485 Kg)
Spent Fuel Enrichment	0.7 w/o ^{235}U	0.85 w/o ^{235}U
Fissile Plutonium Discharged	4.745 Kg/MTU_i	7.178 Kg/$MTHM_i$
Replacement Loadings		
Discharge Burnup	28,400 MWD/MTU	28,010 MWD/MTHM
Core Loading	136.136 MTU	156.032 MTHM
Fresh Fuel Enrichment	2.8 w/o ^{235}U	1.84 w/o ^{235}U
Fissile Plutonium Loaded	N/A	1.29 w/o ^{FIS}Pu (2016 Kg)
Spent Fuel Enrichment	0.8 w/o ^{235}U	0.66 w/o ^{235}U
Fissile Plutonium Discharged	8.242 Kg/MTU_i	11.818 Kg/$MTHM_i$

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(1) Data not available for fuel cycle cost calculations; included for comparison only.

TABLE 6-24

ENERGY ECONOMIC DATA BASE

FUEL CYCLE DATA SOURCE BY REACTOR TYPE

REACTOR TYPE	SYSTEM DESIGNED BY	Fuel Cycle * DATA PROVIDED BY
PWR	Combustion Engineering	Combustion Engineering
BWR	General Electric	General Electric **
HTGR	General Atomic	General Atomic
PHWR	Combustion Engineering	Combustion Engineering
LMFBR	Argonne National Lab. & Hanford Engineering Development Lab.	Department of Energy
GCFR	General Atomic	General Atomic

*Mass flow information provided by source indicated through NASAP.

**BWR data not available for fuel cycle costs; PWR data used for BWR (Model A1).

TABLE 6-25

ENERGY ECONOMIC DATA BASE

DESIGN CHARACTERISTICS OF HTGR

	HTGR-U5/U/Th-20%-T	HTGR-U5(DE)/U/Th-20%
Reactor Thermal Output	3,360 MWt	3,360 MWt
Number of Fuel Blocks	5,288	5,288
Approximate Fraction of Core Replaced at Each Refueling	1/4	1/4
Start of U-233 Recycle	---	Cycle 3
Initial Core (Average)		
Discharge Burnup	52,900 MWD/MTH	52,925 MWD/MTH
Core Loading	41.130 MTH	41.130 MTH
C/Th Ratio	350	350
Thorium Charged	31.802 MT	31.798 MT
Enrichment of Uranium Charged	19.8 w/o U-235	19.8 w/o U-235
Enrichment of Uranium Discharged	12.8 w/o[*]	12.8 w/o[*]
U-233 Discharged	75.5 Kg/MTU$_f$	75.5 Kg/MTU$_f$
Fissile Plutonium Discharged	12.071 Kg/MTU$_f$	12.014 Kg/MTU$_f$
Replacement Loadings		
Discharge Burnup	133,100 MWD/MTH	132,500 MWD/MTH
Core Loading	29.504 MTH	29.648 MTH
C/Th Ratio	850	850
Thorium Charged	446 Kg/MTH$_i$	444 Kg/MTH$_i$
Enrichment of Uranium Charged	19.8 w/o U-235	19.0 w/o[***]
Recycled U-233 Charged	---	11.927 Kg/MTH$_i$
Enrichment of Uranium Discharged	4.9 w/o[**]	4.7 w/o
U-233 Discharged	27.5 Kg/MTU$_f$	28.9 Kg/MTU$_f$
Fissile Plutonium Discharged	13.702 Kg/MTU$_f$	13.630 Kg/MTU$_f$

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[*] Mixture of 625.1 Kg of U-233 and 434.7 Kg of U-235 in total uranium of 8275.9 Kg discharged.

[**] Mixture of 88.3 Kg of U-233 and 69.0 Kg of U-235 in total uranium of 3211.1 Kg discharged.

[***] Mixture of U-235 makeup (696.5 Kg) and U-233 recycled (88.4 Kg) in total uranium loaded (4122.7 Kg).

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TABLE 6-26

ENERGY ECONOMIC DATA BASE

DESIGN CHARACTERISTICS OF PHWR

	PHWR-U5(NAT)/U	PHWR-U5(SE)/U
Reactor Thermal Output	3,990 MWt	3,990 MWt
Number of Coolant Channels	380	380
Number of Fuel Bundles per Channel	12	12
Fuel Type	Oxide Fuel	Oxide Fuel
Initial Core (Average)		
Discharge Burnup	4,759 MWD/MTU	6,556 MWD/MTU
Core Loading	148.388 MTU	148.388 MTU
Fresh Fuel Enrichment	0.711 w/o U-235	0.711 w/o U-235
Replacement Loadings		
Discharge Burnup	6,100 MWD/MTU	19,749 MWD/MTU
Annual Requirement	179.059 MTU	55.304 MTU
Fresh Fuel Enrichment	0.711 w/o U-235	1.2 w/o U-235

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TABLE 6-27

ENERGY ECONOMIC DATA BASE

DESIGN CHARACTERISTICS OF LMFBR

	LMFBR-Pu/U/U/U	LMFBR-Pu/U/Th/Th
Reactor Thermal Output	3,318 MWt	3,411 MWt
Number of Elements		
Core Fuel	678	432
Axial Blanket	678	432
Radial Blanket	420	252
Fuel Type	Oxide Fuel	Oxide Fuel
Breeding Ratio	1.1417	N/A
Initial Core (Average)		
Discharge Burnup	45,983 MWD/MTHM	34,650 MWD/MTHM
Core Loading	22.668 MTHM	34.370 MTHM
Fissile Plutonium Loaded	154.314 Kg/MTH$_i$	121.559 Kg/MTH$_i$
Fissile Plutonium Discharged	136.713 Kg/MTH$_i$	117.457 Kg/MTH$_i$
Initial Uranium Enrichment	0.20 w/o U-235	0.20 w/o U-235
Final Uranium Enrichment	0.13 w/o U-235	0.15 w/o U-235
Replacement Core Loadings		
Discharge Burnup	67,590 MWD/MTHM	53,150 MWD/MTHM
Core Loading	23.316 MTHM	32.994 MTHM
Fissile Plutonium Charged	154.315 Kg/MTH$_i$	121.537 Kg/MTH$_i$
Fissile Plutonium Discharged	134.243 Kg/MTH$_i$	116.142 Kg/MTH$_i$
Initial Uranium Enrichment	0.20 w/o U-235	0.20 w/o U-235
Final Uranium Enrichment	0.13 w/o U-235	0.13 w/o U-235

TABLE 6-27 (cont.)

ENERGY ECONOMIC DATA BASE

DESIGN CHARACTERISTICS OF LMFBR

	LMFBR-Pu/U/U/U	LMFBR-Pu/U/Th/Th
Axial Blanket		
Loading	19.038 MTHM	22.470 MTHM
Fissile Plutonium Discharged	22.691 Kg/MTH$_i$	---
U-233 Discharged	---	18.069 Kg/MTH$_i$
Initial Uranium Enrichment	0.20 w/o U-235	---
Final Uranium Enrichment	0.16 w/o U-235	---
Radial Blanket		
Loading	44.796 MTHM	42.815 MTHM
Fissile Plutonium Discharged	20.895 Kg/MTH$_i$	---
U-233 Discharged	---	16.466 Kg/MTH$_i$
Initial Uranium Enrichment	0.2 w/o U-235	---
Final Uranium Enrichment	0.18 w/o U-235	---

TABLE 6-28
ENERGY ECONOMIC DATA BASE
DESIGN CHARACTERISTICS OF GCFR

	GCFR-Pu/U/U/U	GCFR-Pu/U/Th/Th
Reactor Thermal Output	3,290 MWt	3,290 MWt
Number of Elements		
Core Fuel	253	253
Axial Blanket	253	253
Radial Blanket	198	198
Fuel Type	Oxide Fuel	Oxide Fuel
Conversion Ratio	1.51	1.48
Initial Core (Average)		
Discharge Burnup	50,332 MWD/MTH	50,356 MWD/MTH
Core Loading	28.620 MTH	28.982 MTH
Fissile Plutonium Loaded	138.539 Kg/MTH$_i$	142.330 Kg/MTH$_i$
Fissile Plutonium Discharged	127.079 Kg/MTH$_i$	128.921 Kg/MTH$_i$
Fresh Uranium Enrichment	0.25 w/o U-235	0.25 w/o U-235
Spent Uranium Enrichment	0.17 w/o U-235	0.17 w/o U-235
Replacement Core Loadings		
Discharge Burnup	75,576 MWD/MTH	75,574 MWD/MTH
Core Loading	28.981 MTH	28.981 MTH
Fissile Plutonium Charged	144.885 Kg/MTH$_i$	151.875 Kg/MTH$_i$
Fissile Plutonium Discharged	124.471 Kg/MTH $_i$	127.829 Kg/MTH$_i$
Fresh Uranium Enrichment	0.25 w/o U-235	0.25 w/o U-235
Spent Uranium Enrichment	0.14 w/o U-235	0.14 w/o U-235

TABLE 6-28 (cont.)
ENERGY ECONOMIC DATA BASE
DESIGN CHARACTERISTICS OF GCFR

	GCFR-Pu/U/U/U	GCFR-Pu/U/Th/Th
Axial Blanket		
Loading	33.01 MTH	28.493 MTH
Fissile Plutonium Discharged	28.356 Kg/MTH_i	---
Fissile U-233 Discharged	---	31.787 Kg/MTH_i
Fresh Uranium Enrichment	0.25 w/o U-235	---
Spent Uranium Enrichment	0.20 w/o U-235	---
Radial Blanket		
Loading	99.305	85.938 MTH
Fissile Plutonium Discharged	15.591 Kg/MTH_i	---
Fissile U-233 Discharged	---	16.868 Kg/MTH_i
Fresh Uranium Enrichment	0.25 w/o U-235	---
Spent Uranium Enrichment	0.22 w/o U-235	---

Effective Date - 1/1/78

TABLE 6-29

ENERGY ECONOMIC DATA BASE

SUMMARY OF 30-YEAR LEVELIZED FUEL CYCLE COSTS
($MBtu, January 1978 Dollars)

Reactor/Fuel Cycle Designation	Direct Cost	Indirect Cost	Cycle Cost	Assumed Reactor Commercial Operation Date
PWR-U5(LE)/U-T	0.65	0.07	0.72	1987
PWR-U5(LE)+Pu(RE)/U (1)				
Scenario 1	0.61	0.05	0.66	1991
Scenario 2	0.60	0.05	0.65	1991
HTGR-U5/U/Th-20%-T	0.66	0.09	0.75	1995
HTGR-U5(DE)/U/Th-20%	0.65	0.07	0.72	1995
PHWR-U5(NAT)/U-T (CANDU)	0.71	0.01	0.72	1995
PHWR-U5(SE)/U-T (CANDU)	0.36	0.04	0.40	1995
LMFBR-Pu/U/U/U-HT (1)				
Scenario 1	0.40	-0.01	0.39	2001
Scenario 2	0.48	-0.01	0.47	2001
Scenario 3	0.43	0.30	0.73	2001
LMFBR-Pu/U/Th/Th-HT (1)				
Scenario 1	0.49	-0.01	0.48	2001
Scenario 2	0.44	0.33	0.77	2001
GCFR-Pu/U/U/U (1)				
Scenario 1	0.47	-0.02	0.45	2001
Scenario 2	0.55	-0.01	0.54	2001
Scenario 3	0.24	0.38	0.62	2001
GCFR-Pu/U/Th/Th (1)				
Scenario 1	0.45	-0.02	0.43	2001
Scenario 2	0.30	0.39	0.69	2001

(1) See Appendix G for Fuel Scenario Description

Effective Date - 1/1/78

TABLE 6-30
ENERGY ECONOMIC DATA BASE
SUMMARY BREAKDOWN OF 30-YEAR LEVELIZED
FUEL CYCLE COSTS
($/MBtu, January 1978 Dollars)

Reactor/Fuel Cycle Designation	Start-Up Year	Uranium Supply(1)	Plutonium Supply(2)	Fabrication(3)	Shipping(4)	Reprocessing or Disposal(5)	Total
PWR-U5(LE/U-T)	1987	0.59	0.00	0.08	0.01	0.04	0.72
PWR-U5(LE)+Pu(RE/U)(7)							
Scenario 1	1991	0.44	-0.01	0.12	0.01	0.10	0.66
Scenario 2	1991	0.44	-0.02	0.12	0.01	0.10	0.65
HTGR-U5/U/Th-20%-T	1995	0.65	0.00	0.06	0.02	0.02	0.75
HTGR-U5(DE)/U/Th-20%	1995	0.56	0.00	0.08	0.02	0.06	0.72(6)
PHWR-U5(NAT)/U-T (CANDU)	1995	0.37	0.00	0.22	0.02	0.11	0.72
PHWR-U5(SE)/U-T (CANDU)	1995	0.28	0.00	0.08	0.01	0.03	0.40
LMFBR-Pu/U/U/U-HT(7)							
Scenario 1	2001	0.00	0.00	0.18	0.04	0.17	0.39
Scenario 2	2001	0.00	0.08	0.18	0.04	0.17	0.47
Scenario 3	2001	0.00	0.32	0.18	0.04	0.19	0.73
LMFBR-Pu/U/Th/Th-HT(7)							
Scenario 1	2001	0.00	0.00	0.23	0.04	0.21	0.48
Scenario 2	2001	-0.25	0.53	0.23	0.04	0.22	0.77
GCFR-Pu/U/U/U(7)							
Scenario 1	2001	0.00	0.00	0.20	0.04	0.21	0.45
Scenario 2	2001	0.00	0.09	0.20	0.04	0.21	0.54
Scenario 3	2001	0.00	0.16	0.20	0.04	0.22	0.62
GCFR-Pu/U/Th/Th(7)							
Scenario 1	2001	0.00	0.00	0.20	0.04	0.19	0.43
Scenario 2	2001	-0.39	0.64	0.20	0.04	0.20	0.69

---

(1) Net uranium consumed including U-233 for those fuel cycles involving reprocessing. For throwaway fuel cycles, these figures represent the initial cost of uranium.

(2) Net plutonium consumed.

(3) Total fabrication of all types of fuel including recycle fuel or blanket fuel assemblies, where applicable.

(4) Shipping to reprocessor for those fuel cycles involving reprocessing, or shipping to permanent disposal facility for throwaway fuel cycles.

(5) Reprocessing and HLW disposal, or permanent disposal of spent fuel assemblies.

(6) If the credit for retired uranium and plutonium is assumed, the fuel cost shown here could be reduced by about 0.04 to 0.05 $/MBtu.

(7) See Appendix G for Fuel Scenario Description.

TABLE 6-31

ENERGY ECONOMIC DATA BASE

TEN BASE REACTORS AND THEIR FUELING MODES
30 YEAR LEVELIZED COSTS
(January 1978 Dollars)

REACTOR TYPE	FUELING MODE	COSTS	
		$/MBtu	m/kWh(2)
PWR and BWR(1)	Throwaway (U only)	0.72	7.36
	Reprocess, Recover, and Recycle (MOX)	0.66	6.74
HTGR	Throwaway (U only)	0.75	7.67
	Reprocess, Recover, and Recycle	0.72	7.36
PHWR (CANDU)	Nat. U Throwaway	0.72	8.04
	1.2 w/o ^{235}U - Throwaway	0.40	4.47
LMFBR	U Blanket Recycle Pu	0.39	3.64
	Th Blanket Recover ^{233}U	0.48	4.48
GCFR	U Blanket Recycle Pu	0.45	4.20
	Th Blanket Recover ^{233}U for PW	0.43	4.01

(1) BWR data not available for fuel costs; PWR data used for BWR (Model A1).

(2) Based on net plant heat rates given in Table 4-1.

Effective Date - 1/1/78

TABLE 6-32

ENERGY ECONOMIC DATA BASE

FUEL CYCLE COST COMPONENTS PERCENTAGE VALUES

Reactor Type	Fueling Mode	Percent of Total Fuel Cycle Cost		
		Uranium Supply	Fuel Fabrication	Shipping and Reprocessing/ Spent Fuel Disposal
PWR BWR(1)	Throwaway	82	11	7
	Reprocess, Recover, and Recycle-MOX	67	18	15
HTGR	Throwaway	87	8	5
	Reprocess, Recover, and Recycle	78	11	11
PHWR	Natural 0.711 w/o	51	31	18
	1.2 w/o enriched	70	20	10
LMFBR	U Blanket	0 Pu Fueled	46	54
	Th Blanket	0 Pu Fueled	48	52
GCFR	U Blanket	0 Pu Fueled	44	56
	Th Blanket	0 Pu Fueled	46	54

(1) BWR data not available for fuel costs; PWR data used for BWR (Model A1).

Effective Date - 1/1/78

TABLE 6-33

ENERGY ECONOMIC DATA BASE

AVERAGE DELIVERED CONTRACT PRICES OF STEAM COAL (1)
(Current Year $)

Date	Price		
1976	17.90		
1977	19.25		
1978			
January	16.94	Pre-Settlement 3 month average	$17.34
February	16.50		
March	18.59		
April	21.43	Post-Settlement 9 month average	$22.77
May	22.23		
June	22.88		
July	22.08		
August	22.12		
September	22.66		
October	23.53		
November	24.03		
December	23.99		

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(1) From: May 1979 DOE Monthly Energy Review; p. 95.

Effective Date - 1/1/78

TABLE 6-34

ENERGY ECONOMIC DATA BASE

HIGH SULFUR COAL ANALYSIS

Coal Type : Eastern High Sulfur Bituminous Coal

Location :

State	Illinois
County	St. Clair
Seam	Illinois No. 6

Reserves (Est.): 3,000,000,000 Tons

DESIGN BASIS COAL ANALYSIS

Moisture (Percent by Weight):	11.31
<u>Proximate Analysis (Percent by Weight, Dry)</u>:	
Volatile Matter	39.72
Fixed Carbon	48.68
Ash	11.60
<u>Ultimate Analysis (Percent by Weight, Dry)</u>:	
Carbon	69.33
Hydrogen	4.90
Nitrogen	.86
Chlorine	.04
Sulfur	3.61
Oxygen	9.64
<u>Ash Analysis (Percent by Weight, Dry)</u>:	
P_2O_5	.05
SiO_2	45.73
Fe_2O_3	18.38
Al_2O_3	19.40
TiO_2	1.30
CaO	5.50
MgO	.95
SO_3	6.63
K_2O	1.53
Na_2O	.51
Undetermined	.02
<u>Calorific Value (Btu/lb)</u>	
As Received	11,026
Dry	12,432
<u>Ash Fusion Temperature (°F Red./°F Ox.)</u>	
Initial	1950/2270
H = W	2140/2380
H = 1/2W	2140/2400
Fluid	2250/2500

Effective Date - 1/1/78

TABLE 6-35

ENERGY ECONOMIC DATA BASE

LOW SULFUR COAL ANALYSIS

Coal Type : Western Low Sulfur Sub-Bituminous Coal

Location :
State Wyoming
County Campbell
Seam Roland Smith

Reserves (Est.): 1,000,000,000 Tons

DESIGN BASIS COAL ANALYSIS

Moisture (Percent by Weight)	31.8
<u>Proximate Analysis (Percent by Weight, Dry)</u>:	
Volatile Matter	47.6
Fixed Carbon	45.1
Ash	7.3
<u>Ultimate Analysis (Percent by Weight, Dry)</u>:	
Carbon	69.3
Hydrogen	5.2
Nitrogen	0.9
Sulfur	0.5
Oxygen	16.8
<u>Ash Analysis (Percent by Weight, Dry)</u>:	
SiO_2	28.8
Fe_2O_3	9.0
Al_2O_3	13.0
TiO_2	0.7
CaO	25.0
MgO	6.5
SO_3	18.0
K_2O	0.4
Na_2O	1.2
<u>Calorific Value (Btu/lb)</u>	
As Received	8,164
Dry	11,970
<u>Ash Fusion Temperature (°F Red./°F Ox.)</u>	
Initial	2140/2160
H = W	2180/2190
H = 1/2W	2200/2210
Fluid	2280/2370

Effective Date - 1/1/78

TABLE 6-36

ENERGY ECONOMIC DATA BASE

PITTSBURGH STEAM (HIGH SULFUR) COAL ANALYSIS

Coal Type : Eastern High Sulfur Bituminous Coal

Location :
State Pennsylvania
County Washington
Seam Pittsburgh No. 8

Reserves (Est.) : 6,600,000,000 Tons

DESIGN BASIS COAL ANALYSIS

Moisture (Percent by Weight)	2.4
Proximate Analysis (Percent by Weight, Dry):	
Volatile Matter	39.2
Fixed Carbon	51.2
Ash	7.3
Ultimate Analysis (Percent by Weight):	
Carbon	75.6
Hydrogen	5.2
Nitrogen	1.3
Sulfur	2.6
Oxygen	8.0
Ash Analysis (Percent by Weight, Dry):	
P_2O_5	.28
SiO_2	46.95
Fe_2O_3	18.4
Al_2O_3	25.64
TiO_2	1.01
CaO	2.0
MgO	.67
SO_3	1.97
K_2O	1.75
Na_2O	.45
Calorific Value (Btu/lb)	
As Received	13,156
Dry	13,480
Ash Fusion Temperature (^{o}F)	2,440

FIGURE 6-1
NUCLEAR FUEL CYCLE ACTIVITIES

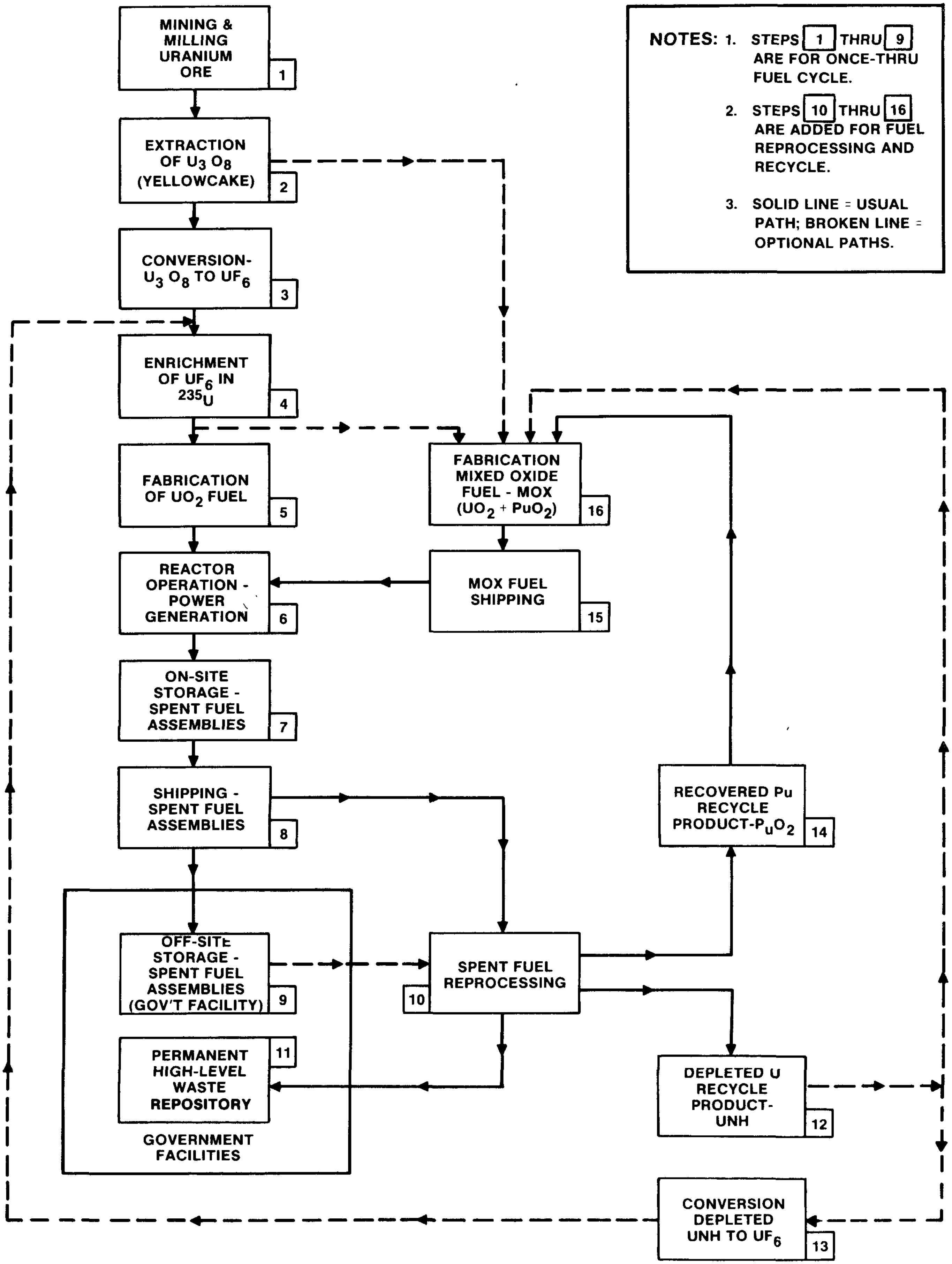
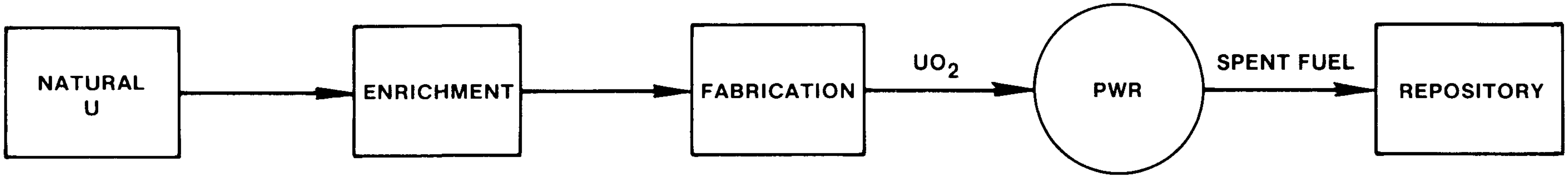
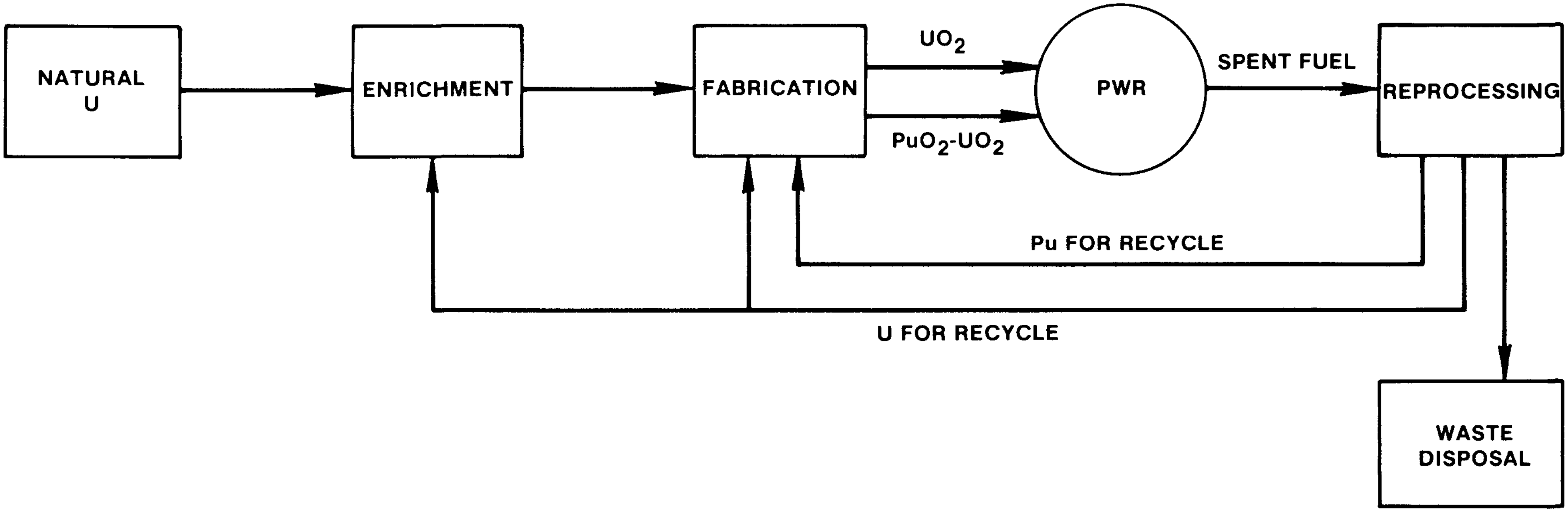


FIGURE 6-2
LWR FUEL CYCLE

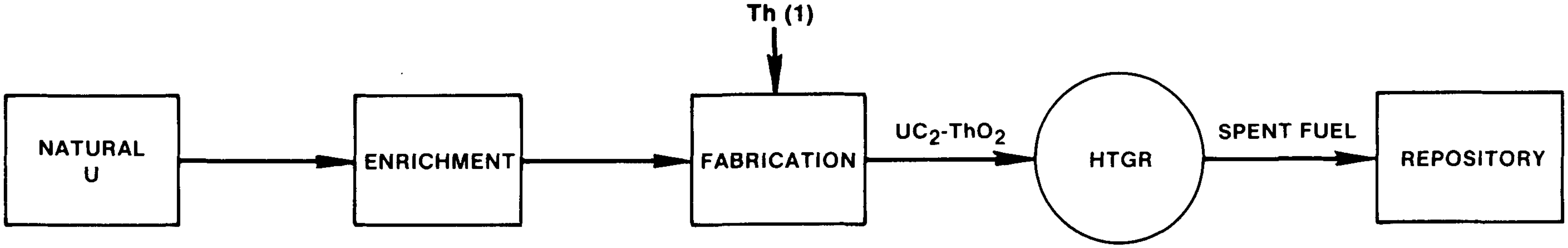


(A) THROW-AWAY CYCLE (PWR-U5(LE)/U-T)

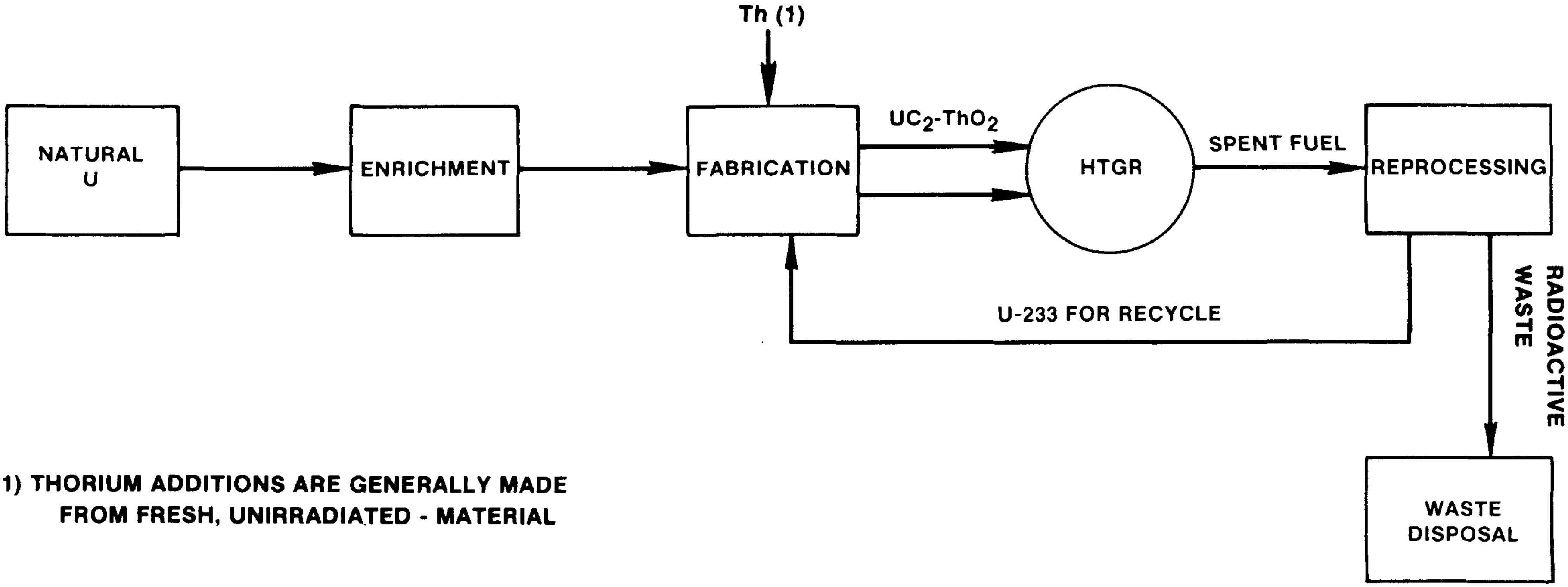


(B) PLUTONIUM AND URANIUM RECYCLE (PWR-U5(LE) + Pu(RE)/U)

FIGURE 6-3
HTGR FUEL CYCLE



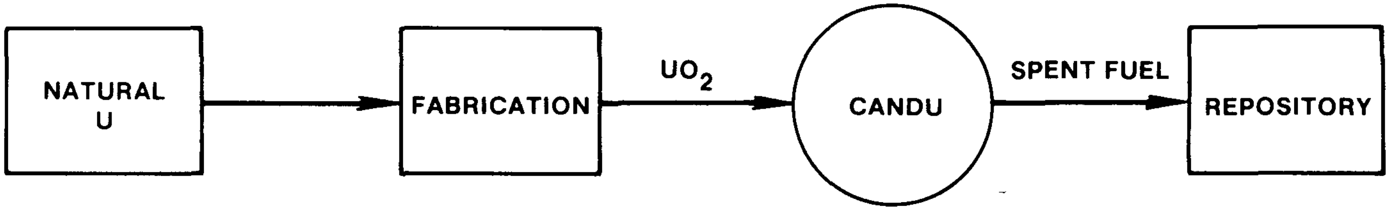
(A) THROW-AWAY CYCLE (HTGR-U5/U/Th-20%-T)



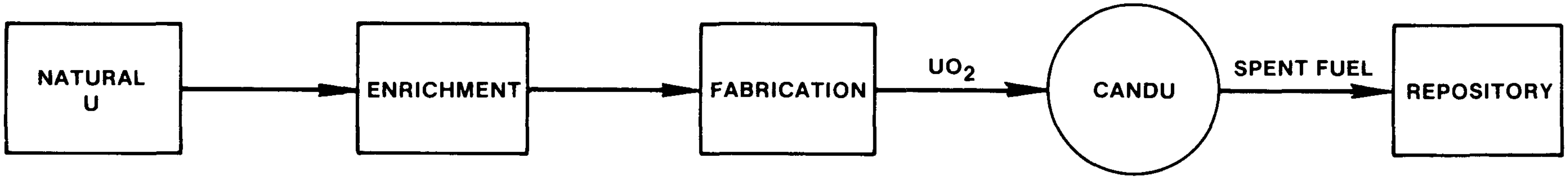
(1) THORIUM ADDITIONS ARE GENERALLY MADE FROM FRESH, UNIRRADIATED - MATERIAL

(B) U-233 RECYCLE (HTGR-U5 (DE)/U/Th-20%)

FIGURE 6-4
PHWR (CANDU) FUEL CYCLE



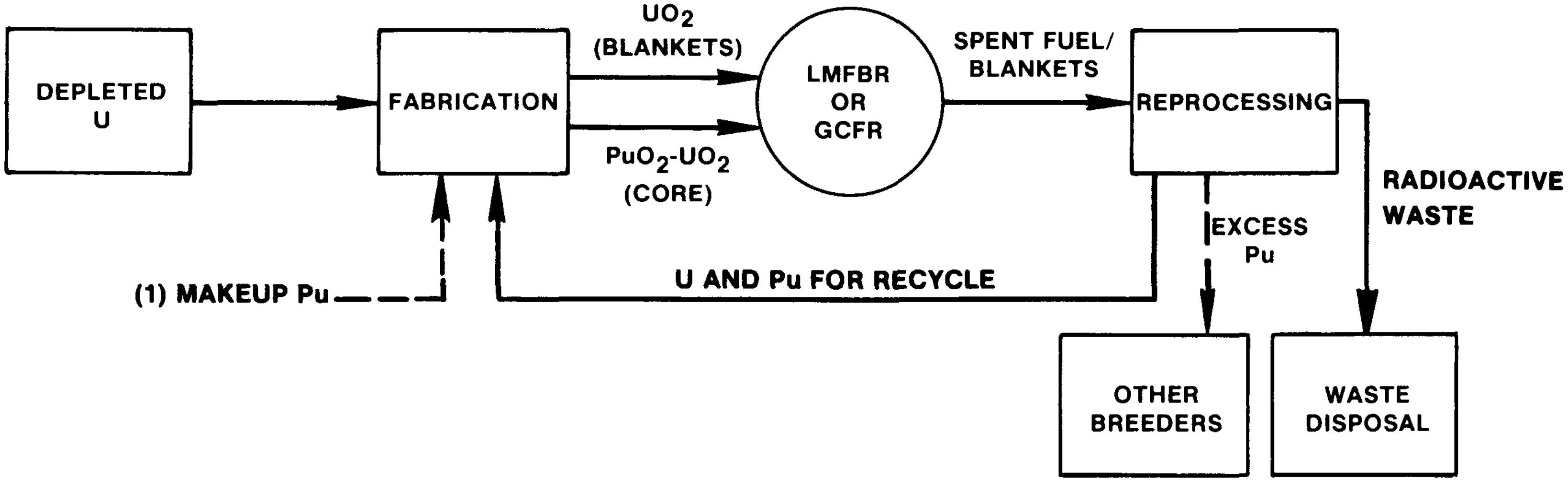
(A) NATURAL URANIUM THROW AWAY CYCLE (CANDU-U5(NAT)/U-T)



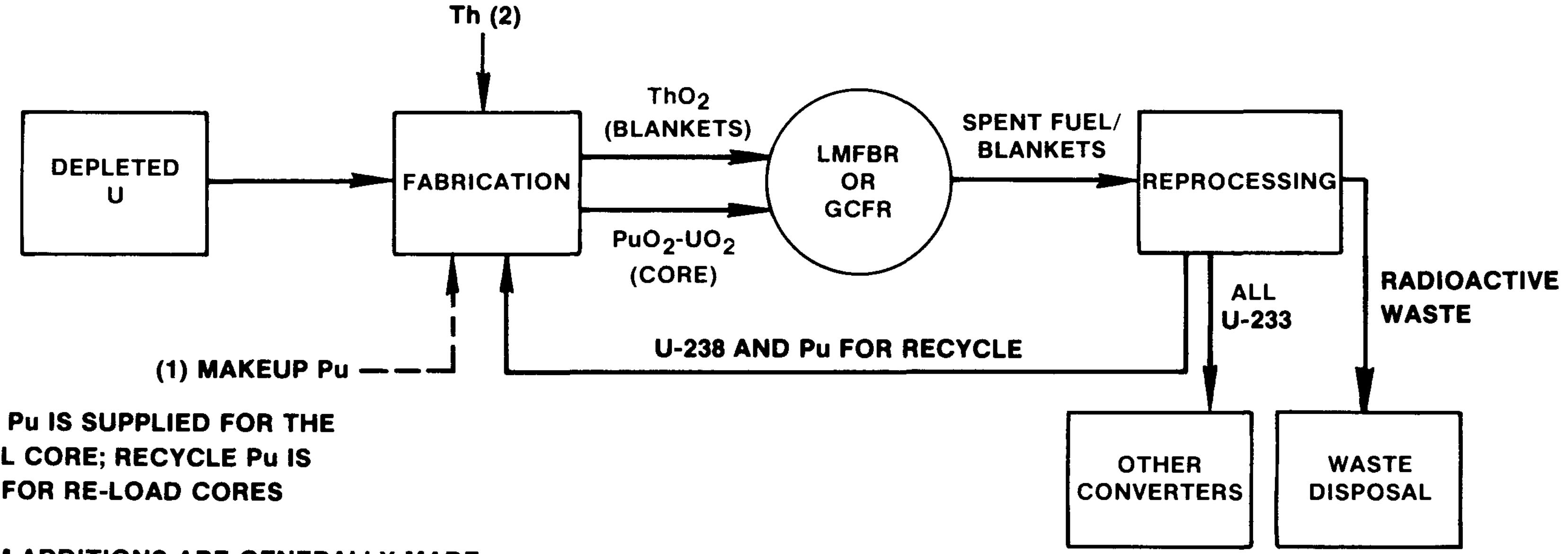
(B) SLIGHTLY ENRICHED URANIUM THROW AWAY CYCLE (CANDU-U5(SE)/U-T)

FIGURE 6-5

LMFBR/GCFR FUEL CYCLE



(A) URANIUM BLANKETS (LMFBR-Pu/U/U/U-HT OR GCFR-Pu/U/U/U)

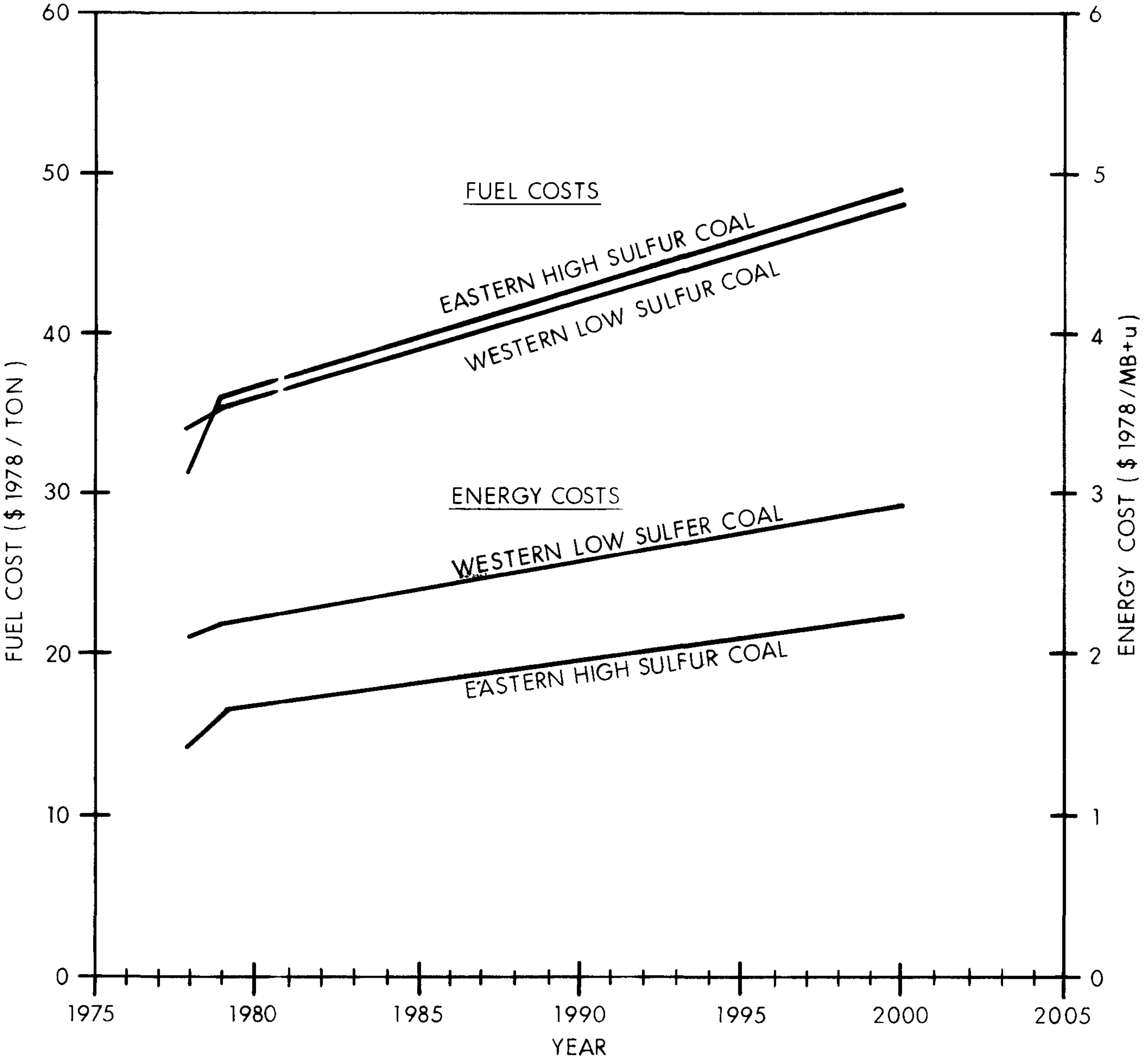


(1) MAKEUP Pu IS SUPPLIED FOR THE INITIAL CORE; RECYCLE Pu IS USED FOR RE-LOAD CORES

(2) THORIUM ADDITIONS ARE GENERALLY MADE FROM FRESH, UNIRRADIATED MATERIAL

(B) THORIUM BLANKETS (LMFBR-Pu/U/Th/Th/ OR GCFR-Pu/U/Th/Th)

FIGURE 6-6
ENERGY ECONOMIC DATA BASE
PROJECTED AVERAGE DELIVERED COAL COSTS
(JANUARY 1978 DOLLARS)



SECTION 7

7.0 OPERATION AND MAINTENANCE COST INITIAL UPDATE

The EEDB Initial Update of the operation and maintenance (O&M) costs is composed of two parts; nuclear and fossil O&M costs. For this report, the accounting breakdown includes the major cost areas for each type of plant but does not define separate expenses for the reactor or boiler plant and the turbine plant. The O&M cost estimates accommodate state-of-the-art designs and current regulations, codes and standards. This section of the report presents the detailed results of the O&M cost update with a description of the major cost changes.

7.1 OPERATION AND MAINTENANCE COST UPDATE PROCEDURE

The procedure for estimating O&M costs was developed by the Oak Ridge National Laboratory and reported in ORNL/TM-6467 "A Procedure for Estimating Nonfuel Operation and Maintenance Costs for Large Steam-Electric Power Plants." The cost estimating procedure involves the combination of empirical functions that represent historical experience with new factors arising from regulatory and economic considerations. This update procedure is applied to the selected technical models tabulated in Tables 1-1 and 1-2 to produce the Operation and Maintenance Cost Initial Update. The means of application of the procedure is OMCOST, a digital computer program developed by ORNL. Input to OMCOST is staffing and material requirements. ORNL prepares and updates these data on a continuing basis.

7.2 OPERATION AND MAINTENANCE COST SUMMARY

O&M costs are prepared for the EEDB Initial Update as the sum of staff, maintenance materials and supply costs and expenses, insurance and fees, and administrative and general expenses. Total O&M costs are summarized for all plants for the year 1978 in Table 7-1.

7.3 DETAILED OPERATING AND MAINTENANCE COSTS

Results of the Operating and Maintenance Cost Initial Update are presented for each technical plant model in Tables 7-2 through 7-12 as follows:

Nuclear Plant Model	Table Number	Fossil Plant Model	Table Number
BWR	7-2	HS12	7-8
HTGR	7-3	HS8	7-9
PWR	7-4	LS12	7-10
PHWR	7-5	LS8	7-11
GCFR	7-6	CGCC	7-12
LMFBR	7-7		

These tables contain all of the O&M data available in the EEDB. There is no additional data in the Backup Data File. Tabulations for the CLIQ Fossil Plant Models are not included, because resources are not available for this data.

7.4 OPERATION AND MAINTENANCE COST MODEL UPDATE

To quantify staff requirements, staff for both nuclear and fossil-fueled plants are organized according to function. Fossil-fueled plants, although their organization is similar to that of nuclear plants with regard to plant operation functions, differ in personnel allotment and job classifications. In addition, they do not require staffing for quality assurance or health physics. The total staffing used in this study for nuclear and fossil-fueled plants is shown as follows:

Plant Model	Table Number
LWR Power Plants (BWR and PWR)	7-13
HTGR Power Plants	7-14
PHWR Power Plants	7-15
GCFR Power Plants	7-16
LMFBR Power Plants	7-17
Coal-Fired Power Plants with FGD Systems (HS12 and HS8)	7-18
Coal-Fired Power Plants without FGD Systems (LS12 and LS8)	7-19

Although licensed reactor operators may receive a five to ten percent premium, fossil-fueled and nuclear plant personnel are assigned the same hourly rates. Nonlicensed jobs in fossil and nuclear work are not significantly different in function. However, considerably more preparation and training may be required to learn nuclear plant procedure for repairs and inspections.

The amount of the various major replacement items, expendable materials, and services used to maintain the power plant, is variable throughout the plant life. To date, historical data on new plant designs are not extensive enough to provide direct relationships for large plants. Therefore, the relationship of materials to maintenance labor as a percentage is estimated for an 80 percent plant capacity factor. Results were discussed with operating personnel as a check.

Operation and maintenance of coal-fired plants tend to be more labor intensive than that of LWR plants because of the routine maintenance involved with burning coal and the effect of high operating temperatures on the equipment.

Maintenance costs are estimated for operation at base-load conditions near 100 percent capability.

Variable maintenance costs are judged on the basis that 25 percent of the total maintenance is subject to change with load when operating between 50 and 80 percent capacity factor. This judgment is based on factors known to influence incremental costs for coal pulverizers, fuel handling, heat transfer surfaces and certain nonfuel supplies sensitive to load.

The nonregenerative limestone-slurry scrubbing process is used to show a process with high sulfur removal and with economics intermediate among the various systems available.

The maintenance material cost factors as a percentage of maintenance labor cost are as follows:

	Percentage of Maintenance Labor Cost		
	Fixed	Variable	Total
LWR	100	0	100
Coal with FGD*	62	20	82

*Flue Gas Desulfurization

The O&M costs for cooling the main turbine condenser water and other plant heat exchangers have been considered for evaporative cooling towers only. These costs ranged from $25,000 to $50,000 annually for coal and nuclear plants.

Supplies and expenses include certain consumable materials and expenses that are unrecoverable after use in O&M activities. These include makeup fluids, chemical gases, lubricants, office and personnel supplies, monitoring and record services, and offsite contract services. Costs of limestone and offsite sludge disposal associated with the limestone slurry scrubbing process for FGD are also included.

Operators of nuclear power plants are required to maintain financial protection to a total limit of $560,000,000. This limit is divided as of January 1978 as follows:

	$\$10^6$
Private Insurance	140
Retrospective Premium	340
Government Indemnity	80
	560

The estimated annual premiums for nuclear insurance are as follows:

Commercial Coverage ($140 million)	$284,000
Retrospective Premium	$ 6,000
Government Coverage ($ 80 million)	6 $/MWt to 3000 MWt

Safety, environmental, and health physics inspections are routinely performed at specified frequencies for purposes of reviewing a licensed program by the Nuclear Regulatory Commission. The annual estimate for these inspections is $100,000 for the first unit and $80,000 for each additional unit.

Administrative and general expenses include the owner's offsite salaries and expenses directly allocable to a specific power production facility. In this report the magnitude of administrative and general expenses is related to fixed O&M costs, minus insurance and operating fees. Values of 10 and 15 percent of total fixed cost of staff, maintenance materials, and supplies and expenses have been used to estimate administrative and general costs for fossil and nuclear plants respectively.

7.5 LEVELIZATION FACTOR

The Operation and Maintenance costs for the EEDB Initial Update are stated in terms of first year cost (i.e., 1978 dollars). If one wishes to compute a generating cost for uninflated operation and maintenance, then the first year cost, after conversion to an electric energy cost, may be added directly to the uninflated capital, fuel cycle, and other costs. For an inflated case, a levelization factor must be computed and applied to the first year cost before the O&M costs are added to the inflated capital and fuel cycle cost. Consistent rates of interest and escalation must be used in the computation for compatibility and consistency with the capital and fuel cycle costs. An approximation of the levelization factor may be computed with the following equation:

$$LF = \left[\frac{i\ (1 + e)}{i - e}\right] \left[\frac{(1 + i)^n - (1 + e)^n}{(1 + i)^n - 1}\right]$$

Where:
LF = levelization factor
i = interest rate per annum
e = escalation rate per annum
n = levelization period in years

TABLE 7-1

ENERGY ECONOMIC DATA BASE

OPERATION AND MAINTENANCE COST UPDATE
(Constant $1978)

Model	MWe	$\$10^6$/yr	Mills/kWh
BWR	1190	13.6	1.9
HTGR	1330	12.9	1.6
PWR	1139	13.6	1.9
PHWR	1162	16.8	2.4
GCFR	917	15.3	2.7
LMFBR	1390	17.6	2.1
HS12	1232	22.0	2.9
HS8	795	18.2	3.7
LS12	1243	10.3	1.4
LS8	802	9.8	2.0
CGCC	630	7.7	1.4
CLIQ	*	*	*

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*Not Available

TABLE 7-2
ENERGY ECONOMIC DATA BASE
(Constant $1978)

Effective Date - 1/1/78

```
SUMMARY OF ANNUAL NONFUEL OPERATION AND MAINTENANCE COSTS
   FOR BASE-LOAD STEAM-ELECTRIC POWER PLANTS IN 1978.0

     PLANT TYPE IS BWR
     WITH EVAPORATIVE COOLING TOWERS
     NUMBER OF UNITS PER STATION 1
     THERMAL INPUT PER UNIT IS 3578. MWT
     PLANT NET HEAT RATE  10259.
     PLANT NET EFFICIENCY, PERCENT   33.26
     EACH UNIT IS 1190. MWE NET RATING
     ANNUAL NET GENERATION, MILLION KWH  7302.
     WITH A PLANT FACTOR OF 0.70

     STAFF, $1000/YR                     5034. (215 PERSONS AT $23412.)

     MAINTENANCE MATERIAL, $1000/YR      1850.
               FIXED                          1850.
               VARIABLE                          0.

     SUPPLIES AND EXPENSES, $1000/YR     4638.
               FIXED                          4200.
               VARIABLE                        438.

     INSURANCE AND FEES, $1000/YR         408.
               COMM. LIAB. INS.                284.
               GOV. LIAB. INS.                  18.
               RETROSPECTIVE PREMIUM             6.
               INSPECTION FEES & EXPENSES      100.

     ADMIN. AND GENERAL, $1000/YR        1662.

     TOTAL FIXED COSTS, $1000/YR                       13153.
     TOTAL VARIABLE COSTS, $1000/YR                      438.
     TOTAL ANNUAL O & M COSTS, $1000/YR                13592.

     FIXED UNIT O & M COSTS, MILLS/KWH(E)                1.80
     VARIABLE UNIT O & M COSTS, MILLS/KWH(E)             0.06
     TOTAL UNIT O & M COSTS, MILLS/KWH(E)                1.86
```

TABLE 7-3
ENERGY ECONOMIC DATA BASE
(Constant $1978)

Effective Date - 1/1/78

```
SUMMARY OF ANNUAL NONFUEL OPERATION AND MAINTENANCE COSTS
   FOR BASE-LOAD STEAM-ELECTRIC POWER PLANTS IN 1978.0

     PLANT TYPE IS HTGR
     WITH EVAPORATIVE COOLING TOWERS
     NUMBER OF UNITS PER STATION 1
     THERMAL INPUT PER UNIT IS 3269. MWT
     PLANT NET HEAT RATE   8387.
     PLANT NET EFFICIENCY, PERCENT   40.69
     EACH UNIT IS 1330. MWE NET RATING
     ANNUAL NET GENERATION, MILLION KWH  8161.
     WITH A PLANT FACTOR OF 0.70

     STAFF, $1000/YR                     5034. (215 PERSONS AT $23412.)

     MAINTENANCE MATERIAL, $1000/YR      1850.
               FIXED                          1850.
               VARIABLE                          0.

     SUPPLIES AND EXPENSES, $1000/YR     4026.
               FIXED                          3700.
               VARIABLE                        326.

     INSURANCE AND FEES, $1000/YR         408.
               COMM. LIAB. INS.                284.
               GOV. LIAB. INS.                  18.
               RETROSPECTIVE PREMIUM             6.
               INSPECTION FEES & EXPENSES      100.

     ADMIN. AND GENERAL, $100C/YR        1587.

     TOTAL FIXED COSTS, $1000/YR                  12578.
     TOTAL VARIABLE COSTS, $1000/YR                 326.
     TOTAL ANNUAL O & M COSTS, $1000/YR           12905.

     FIXED UNIT O & M COSTS, MILLS/KWH(E)           1.54
     VARIABLE UNIT O & M COSTS, MILLS/KWH(E)        0.04
     TOTAL UNIT O & M COSTS, MILLS/KWH(E)           1.58
```

TABLE 7-4
ENERGY ECONOMIC DATA BASE
(Constant $1978)

Effective Date - 1/1/78

```
SUMMARY OF ANNUAL NONFUEL OPERATION AND MAINTENANCE COSTS
   FOR BASE-LOAD STEAM-ELECTRIC POWER PLANTS IN 1978.0

     PLANT TYPE IS PWR
     WITH EVAPORATIVE COOLING TOWERS
     NUMBER OF UNITS PER STATION 1
     THERMAL INPUT PER UNIT IS 3412. MWT
     PLANT NET HEAT RATE  10221.
     PLANT NET EFFICIENCY, PERCENT   33.38
     EACH UNIT IS 1139. MWE NET RATING
     ANNUAL NET GENERATION, MILLION KWH  6989.
     WITH A PLANT FACTOR OF 0.70

     STAFF, $1000/YR                     5034. (215 PERSONS AT $23412.)

     MAINTENANCE MATERIAL, $1000/YR      1850.
               FIXED                          1850.
               VARIABLE                          0.

     SUPPLIES AND EXPENSES, $1000/YR     4619.
               FIXED                          4200.
               VARIABLE                        419.

     INSURANCE AND FEES, $1000/YR         408.
               COMM. LIAB. INS.                284.
               GOV. LIAB. INS.                  18.
               RETROSPECTIVE PREMIUM             6.
               INSPECTION FEES & EXPENSES      100.

     ADMIN. AND GENERAL, $1000/YR        1662.

     TOTAL FIXED COSTS, $1000/YR                    13153.
     TOTAL VARIABLE COSTS, $1000/YR                   419.
     TOTAL ANNUAL O & M COSTS, $1000/YR             13573.

     FIXED UNIT O & M COSTS, MILLS/KWH(E)            1.88
     VARIABLE UNIT O & M COSTS, MILLS/KWH(E)         0.06
     TOTAL UNIT O & M COSTS, MILLS/KWH(E)            1.94
```

TABLE 7-5

ENERGY ECONOMIC DATA BASE

(Constant $1978)

Effective Date - 1/1/78

```
SUMMARY OF ANNUAL NONFUEL OPERATION AND MAINTENANCE COSTS
   FOR BASE-LOAD STEAM-ELECTRIC POWER PLANTS IN 1978.0

     PLANT TYPE IS PHWR
     WITH EVAPORATIVE COOLING TOWERS
     NUMBER OF UNITS PER STATION 1
     THERMAL INPUT PER UNIT IS 3800. MWT
     PLANT NET HEAT RATE  11158.
     PLANT NET EFFICIENCY, PERCENT    30.58
     EACH UNIT IS 1162. MWE NET RATING
     ANNUAL NET GENERATION, MILLION KWH  7130.
     WITH A PLANT FACTOR OF 0.70

     STAFF, $1000/YR                     4589. (196 PERSONS AT $23412.)

     MAINTENANCE MATERIAL, $1000/YR      1405.
               FIXED                          1405.
               VARIABLE                          0.

     SUPPLIES AND EXPENSES, $1000/YR     8294.
               FIXED - PLANT                  4500.
                     - HEAVY WATER LOSSES
                       AND UPKEEP             3366.
               VARIABLE                        428.

     INSURANCE AND FEES, $1000/YR         408.
               COMM. LIAB. INS.                284.
               GOV. LIAB. INS.                  18.
               RETROSPECTIVE PREMIUM             6.
               INSPECTION FEES & EXPENSES      100.

     ADMIN. AND GENERAL, $1000/YR        2079.

     TOTAL FIXED COSTS, $1000/YR                  16346.
     TOTAL VARIABLE COSTS, $1000/YR                 428.
     TOTAL ANNUAL O & M COSTS, $1000/YR           16774.

     FIXED UNIT O & M COSTS, MILLS/KWH(E)           2.29
     VARIABLE UNIT O & M COSTS, MILLS/KWH(E)        0.06
     TOTAL UNIT O & M COSTS, MILLS/KWH(E)           2.35
```

TABLE 7-6
ENERGY ECONOMIC DATA BASE
(Constant $1978)

Effective Date - 1/1/78

```
SUMMARY OF ANNUAL NONFUEL OPERATION AND MAINTENANCE COSTS
   FOR BASE-LOAD STEAM-ELECTRIC POWER PLANTS IN 1978.0

     PLANT TYPE IS GCFR
     WITH EVAPORATIVE COOLING TOWERS
     NUMBER OF UNITS PER STATION 1
     THERMAL INPUT PER UNIT IS 2420. MWT
     PLANT NET HEAT RATE   9005.
     PLANT NET EFFICIENCY, PERCENT   37.89
     EACH UNIT IS  917. MWE NET RATING
     ANNUAL NET GENERATION, MILLION KWH  5627.
     WITH A PLANT FACTOR OF 0.70

     STAFF, $1000/YR                     5268. (225 PERSONS AT $23412.)

     MAINTENANCE MATERIAL, $1000/YR      2774.
               FIXED                          2774.
               VARIABLE                          0.

     SUPPLIES AND EXPENSES, $1000/YR     4981.
               FIXED                          4700.
               VARIABLE                        281.

     INSURANCE AND FEES, $1000/YR         405.
               COMM. LIAB. INS.                284.
               GOV. LIAB. INS.                  15.
               RETROSPECTIVE PREMIUM             6.
               INSPECTION FEES & EXPENSES      100.

     ADMIN. AND GENERAL, $1000/YR        1911.

     TOTAL FIXED COSTS, $1000/YR                   15058.
     TOTAL VARIABLE COSTS, $1000/YR                  281.
     TOTAL ANNUAL O & M COSTS, $1000/YR            15339.

     FIXED UNIT O & M COSTS, MILLS/KWH(E)            2.68
     VARIABLE UNIT O & M COSTS, MILLS/KWH(E)         0.05
     TOTAL UNIT O & M COSTS, MILLS/KWH(E)            2.73
```

TABLE 7-7
ENERGY ECONOMIC DATA BASE
(Constant $1978)

Effective Date - 1/1/78

```
SUMMARY OF ANNUAL NONFUEL OPERATION AND MAINTENANCE COSTS
   FOR BASE-LOAD STEAM-ELECTRIC POWER PLANTS IN 1978.0

     PLANT TYPE IS LMFBR
     WITH EVAPORATIVE COOLING TOWERS
     NUMBER OF UNITS PER STATION 1
     THERMAL INPUT PER UNIT IS 3800. MWT
     PLANT NET HEAT RATE   9328.
     PLANT NET EFFICIENCY, PERCENT   36.58
     EACH UNIT IS 1390. MWE NET RATING
     ANNUAL NET GENERATION, MILLION KWH  8529.
     WITH A PLANT FACTOR OF 0.70

     STAFF, $1000/YR                     5268. (225 PERSONS AT $23412.)

     MAINTENANCE MATERIAL, $1000/YR      4316.
               FIXED                          4316.
               VARIABLE                          0.

     SUPPLIES AND EXPENSES, $1000/YR     5426.
               FIXED                          5000.
               VARIABLE                        426.

     INSURANCE AND FEES, $1000/YR         408.
               COMM. LIAB. INS.                284.
               GOV. LIAB. INS.                  18.
               RETROSPECTIVE PREMIUM             6.
               INSPECTION FEES & EXPENSES      100.

     ADMIN. AND GENERAL, $1000/YR        2187.

     TOTAL FIXED COSTS, $1000/YR                  17179.
     TOTAL VARIABLE COSTS, $1000/YR                 426.
     TOTAL ANNUAL O & M COSTS, $1000/YR           17605.

     FIXED UNIT O & M COSTS, MILLS/KWH(E)           2.01
     VARIABLE UNIT O & M COSTS, MILLS/KWH(E)        0.05
     TOTAL UNIT O & M COSTS, MILLS/KWH(E)           2.06
```

TABLE 7-8
ENERGY ECONOMIC DATA BASE
(Constant $1978)

Effective Date - 1/1/78

```
SUMMARY OF ANNUAL NONFUEL OPERATION AND MAINTENANCE COSTS
   FOR BASE-LOAD STEAM-ELECTRIC POWER PLANTS IN 1978.0

     PLANT TYPE IS COAL
     WITH EVAPORATIVE COOLING TOWERS
     NUMBER OF UNITS PER STATION 1
     WITH FGD SYSTEMS
     THERMAL INPUT PER UNIT IS 3299. MWT
     PLANT NET HEAT RATE   9137.
     PLANT NET EFFICIENCY, PERCENT   37.34
     EACH UNIT IS 1232. MWE NET RATING
     ANNUAL NET GENERATION, MILLION KWH  7560.
     WITH A PLANT FACTOR OF 0.70

     STAFF, $1000/YR                      5800. (259 PERSONS AT $22394.)

     MAINTENANCE MATERIAL, $1000/YR       2449.
               FIXED                           1896.
               VARIABLE                         553.

     SUPPLIES AND EXPENSES, $1000/YR     12879.
               FIXED                           1400.
               VAR.  - PLANT                    378.
                     - ASH & FGD SLUDGE       11101.

     ADMIN. AND GENERAL, $1000/YR          910.

     TOTAL FIXED COSTS, $1000/YR                    10006.
     TOTAL VARIABLE COSTS, $1000/YR                 12032.
     TOTAL ANNUAL O & M COSTS, $1000/YR             22038.

     FIXED UNIT O & M COSTS, MILLS/KWH(E)             1.32
     VARIABLE UNIT O & M COSTS, MILLS/KWH(E)          1.59
     TOTAL UNIT O & M COSTS, MILLS/KWH(E)             2.92




     HEATING VALUE OF COAL, BTU/LB        11026.
     COAL BURNED, TONS/YEAR             3132283.
     PERCENT ASH                            11.60
     COST OF ASH DISPOSAL, $/TON             4.00
     PERCENT SULFUR                          3.50
     SULFUR (ORIGINAL),TONS/YR           109630.
     TONS LIMESTONE PER TON SULFUR           4.00
     TONS/YEAR LIMESTONE                 438520.
     COST OF LIMESTONE, $/TON               10.00
     COST OF SLUDGE DISPOSAL, $/DRY TON     12.00
```

TABLE 7-9
ENERGY ECONOMIC DATA BASE
(Constant $1978)

Effective Date - 1/1/78

```
SUMMARY OF ANNUAL NONFUEL OPERATION AND MAINTENANCE COSTS
   FOR BASE-LOAD STEAM-ELECTRIC POWER PLANTS IN 1978.0

     PLANT TYPE IS COAL
     WITH EVAPORATIVE COOLING TOWERS
     NUMBER OF UNITS PER STATION 1
     WITH FGD SYSTEMS
     THERMAL INPUT PER UNIT IS 2208. MWT
     PLANT NET HEAT RATE   9477.
     PLANT NET EFFICIENCY, PERCENT   36.01
     EACH UNIT IS  795. MWE NET RATING
     ANNUAL NET GENERATION, MILLION KWH  4878.
     WITH A PLANT FACTOR OF 0.70

     STAFF, $1000/YR                     5800. (259 PERSONS AT $22394.)

     MAINTENANCE MATFRIAL, $1000/YR      2449.
               FIXED                          1896.
               VARIABLE                        553.

     SUPPLIES AND EXPENSES, $1000/YR     9074.
               FIXED                          1400.
               VAR.  - PLANT                   244.
                     - ASH & FGD SLUDGE       7430.

     ADMIN. AND GENERAL, $1000/YR         910.

     TOTAL FIXED COSTS, $1000/YR                  10006.
     TOTAL VARIABLE COSTS, $1000/YR                8227.
     TOTAL ANNUAL O & M COSTS, $1000/YR           18233.

     FIXED UNIT O & M COSTS, MILLS/KWH(E)           2.05
     VARIABLE UNIT O & M COSTS, MILLS/KWH(E)        1.69
     TOTAL UNIT O & M COSTS, MILLS/KWH(E)           3.74
```

```
     HEATING VALUE OF COAL, BTU/LB        11026.
     COAL BURNED, TONS/YEAR             2096417.
     PERCENT ASH                           11.60
     COST OF ASH DISPOSAL, $/TON            4.00
     PERCENT SULFUR                         3.50
     SULFUR (ORIGINAL),TONS/YR            73375.
     TONS LIMESTONE PER TON SULFUR          4.00
     TONS/YEAR LIMESTONE                 293498.
     COST OF LIMESTONE, $/TON              10.00
     COST OF SLUDGE DISPOSAL, $/DRY TON    12.00
```

TABLE 7-10
ENERGY ECONOMIC DATA BASE
(Constant $1978)

Effective Date - 1/1/78

```
SUMMARY OF ANNUAL NONFUEL OPERATION AND MAINTENANCE COSTS
   FOR BASE-LOAD STEAM-ELECTRIC POWER PLANTS IN 1978.0

     PLANT TYPE IS COAL
     WITH EVAPORATIVE COOLING TOWERS
     NUMBER OF UNITS PER STATION 1
     WITHOUT FGD SYSTEMS
     THERMAL INPUT PER UNIT IS 3444. MWT
     PLANT NET HEAT RATE   9454.
     PLANT NET EFFICIENCY, PERCENT   36.09
     EACH UNIT IS 1243. MWE NET RATING
     ANNUAL NET GENERATION, MILLION KWH  7627.
     WITH A PLANT FACTOR OF 0.70

     STAFF, $1000/YR                     4971. (222 PERSONS AT $22394.)

     MAINTENANCE MATERIAL, $1000/YR      1707.
               FIXED                          1321.
               VARIABLE                        385.

     SUPPLIES AND EXPENSES, $1000/YR     2895.
               FIXED                          1300.
               VAR.  - PLANT                   305.
                     - ASH DISPOSAL           1290.

     ADMIN. AND GENERAL, $1000/YR         759.

     TOTAL FIXED COSTS, $1000/YR                   8352.
     TOTAL VARIABLE COSTS, $1000/YR                1980.
     TOTAL ANNUAL O & M COSTS, $1000/YR           10332.

     FIXED UNIT O & M COSTS, MILLS/KWH(E)          1.10
     VARIABLE UNIT O & M COSTS, MILLS/KWH(E)       0.26
     TOTAL UNIT O & M COSTS, MILLS/KWH(E)          1.35




     HEATING VALUE OF COAL, BTU/LB         8164.
     COAL BURNED, TONS/YEAR             4416282.
     PERCENT ASH                            7.30
     COST OF ASH DISPOSAL, $/TON            4.00
```

TABLE 7-11
ENERGY ECONOMIC DATA BASE
(Constant $1978)

Effective Date - 1/1/78

```
SUMMARY OF ANNUAL NONFUEL OPERATION AND MAINTENANCE COSTS
   FOR BASE-LOAD STEAM-ELECTRIC POWER PLANTS IN 1978.0

     PLANT TYPE IS COAL
     WITH EVAPORATIVE COOLING TOWERS
     NUMBER OF UNITS PER STATION 1
     WITHOUT FGD SYSTEMS
     THERMAL INPUT PER UNIT IS 2306. MWT
     PLANT NET HEAT RATE   9811.
     PLANT NET EFFICIENCY, PERCENT   34.78
     EACH UNIT IS  802. MWE NET RATING
     ANNUAL NET GENERATION, MILLION KWH  4921.
     WITH A PLANT FACTOR OF 0.70

     STAFF, $1000/YR                    4971. (222 PERSONS AT $22394.)

     MAINTENANCE MATERIAL, $1000/YR     1707.
               FIXED                         1321.
               VARIABLE                       385.

     SUPPLIES AND EXPENSES, $1000/YR    2360.
               FIXED                         1300.
               VAR.  - PLANT                  197.
                     - ASH DISPOSAL           863.

     ADMIN. AND GENERAL, $1000/YR        759.

     TOTAL FIXED COSTS, $1000/YR                       8352.
     TOTAL VARIABLE COSTS, $1000/YR                    1446.
     TOTAL ANNUAL O & M COSTS, $1000/YR                9798.

     FIXED UNIT O & M COSTS, MILLS/KWH(E)               1.70
     VARIABLE UNIT O & M COSTS, MILLS/KWH(E)            0.29
     TOTAL UNIT O & M COSTS, MILLS/KWH(E)               1.99




     HEATING VALUE OF COAL, BTU/LB         8164.
     COAL BURNED, TONS/YEAR             2957011.
     PERCENT ASH                           7.30
     COST OF ASH DISPOSAL, $/TON           4.00
```

TABLE 7-12
ENERGY ECONOMIC DATA BASE
(Constant $1978)

SUMMARY OF ANNUAL NONFUEL OPERATION AND MAINTENANCE COSTS FOR BASE-LOAD STEAM-ELECTRIC POWER PLANTS IN 1978.0

PLANT TYPE IS COAL GASIFICATION COMBINED CYCLE
WITH NATURAL DRAFT DRY COOLING TOWER
NUMBER OF UNITS PER STATION 1
WITH FUEL GAS DESULFURIZATION SYSTEM (STRETFORD)
THERMAL INPUT PER UNIT IS 1520 MWt
PLANT NET HEAT RATE 8125
PLANT NET EFFICIENCY, PERCENT 41.4
EACH UNIT IS 630 MWe NET RATING
ANNUAL NET GENERATION, MILLION kWh 3865
WITH A PLANT FACTOR OF 0.70

STAFF, $1000/YR	$4180			
MAINTENANCE MATERIAL, $1000/YR	1542			
FIXED		1162		
VARIABLE		380		
SUPPLIES AND EXPENSES, $1000/YR	$1123			
FIXED		160		
VAR. - PLANT		293		
- ASH & SULFUR DISPOSAL		670		
ADMIN. AND GENERAL, $1000/YR	820			
TOTAL FIXED COSTS, $1000/YR			6172	
TOTAL VARIABLE COSTS, $1000/YR			1493	
TOTAL ANNUAL O&M COSTS, $1000/YR			7665	
FIXED UNIT O&M COSTS, MILLS/kWh(E)				1.12
VARIABLE UNIT O&M COSTS, MILLS/kWh(E)				.27
TOTAL UNIT O&M COSTS, MILLS/kWh(E)				1.39

TABLE 7-13
ENERGY ECONOMIC DATA BASE
(Constant $1978)

Effective Date - 1/1/78

STAFF REQUIREMENT FOR LWR POWER PLANTS

	UNIT SIZE RANGE MW(E)							
	400-700				701-1300			
	NO. UNITS PER SITE				NO. UNITS PER SITE			
	1	2	3	4	1	2	3	4
PLANT MANAGER'S OFFICE								
MANAGER	1	1	1	1	1	1	1	1
ASSISTANT	1	2	3	4	1	2	3	4
QUALITY ASSURANCE	3	4	5	6	3	4	5	6
ENVIRONMENTAL CONTROL	1	1	1	1	1	1	1	1
PUBLIC RELATIONS	1	1	1	1	1	1	1	1
TRAINING	1	1	2	2	1	1	2	2
SAFETY	1	1	1	1	1	1	1	1
ADMIN. & SERVICES	13	15	17	19	13	15	17	19
HEALTH SERVICES	1	1	1	2	1	1	1	2
SECURITY	56	56	56	66	56	56	56	66
SUBTOTAL	79	83	88	103	79	83	88	103
OPERATIONS								
SUPERVISION (EXC. SHIFT)	2	2	4	4	2	2	4	4
SHIFTS	28	48	68	88	33	58	83	108
SUBTOTAL	30	50	72	92	35	60	87	112
MAINTENANCE								
SUPERVISION	8	8	10	12	8	8	10	12
CRAFTS	14	22	30	38	16	26	36	46
PEAK MAINT. ANNUALIZED	55	110	165	220	55	110	165	220
SUBTOTAL	77	140	205	270	79	144	211	278
TECHNICAL AND ENGINEERING								
REACTOR	1	2	3	4	1	2	3	4
RADIO-CHEMICAL	2	2	3	4	2	2	3	4
I & C	2	2	3	4	2	2	3	4
PERFORM., REPORTS, TECH.	17	21	25	29	17	21	25	29
SUBTOTAL	22	27	34	41	22	27	34	41
TOTAL	208	300	399	506	215	314	420	534
LESS SECURITY	152	244	343	440	159	258	364	468
LESS SEC., PEAK MAINT	97	134	178	220	104	148	199	248

TABLE 7-14
ENERGY ECONOMIC DATA BASE
(Constant $1978)

Effective Date - 1/1/78

STAFF REQUIREMENT FOR HTGR POWER PLANTS

	UNIT SIZE RANGE MW(E) 700-1500			
	NO. UNITS PER SITE			
	1	2	3	4
PLANT MANAGER'S OFFICE				
MANAGER	1	1	1	1
ASSISTANT	1	2	3	4
QUALITY ASSURANCE	3	4	5	6
ENVIRONMENTAL CONTROL	1	1	1	1
PUBLIC RELATIONS	1	1	1	1
TRAINING	1	1	2	2
SAFETY	1	1	1	1
ADMIN. & SERVICES	13	15	17	19
HEALTH SERVICES	1	1	1	2
SECURITY	56	56	56	66
SUBTOTAL	79	83	88	103
OPERATIONS				
SUPERVISION (EXC. SHIFT)	2	2	4	4
SHIFTS	33	58	83	108
SUBTOTAL	35	60	87	112
MAINTENANCE				
SUPERVISION	8	8	10	12
CRAFTS	16	26	36	46
PEAK MAINT. ANNUALIZED	55	110	165	220
SUBTOTAL	79	144	211	278
TECHNICAL AND ENGINEERING				
REACTOR	1	2	3	4
RADIO-CHEMICAL	2	2	3	4
I & C	2	2	3	4
PERFORM., REPORTS, TECH.	17	21	25	29
SUBTOTAL	22	27	34	41
TOTAL	215	314	420	534
	===	===	===	===
LESS SECURITY	159	258	364	468
LESS SEC., PEAK MAINT	104	148	199	248

TABLE 7-15
ENERGY ECONOMIC DATA BASE
(Constant $1978)

Effective Date - 1/1/78

STAFF REQUIREMENT FOR PHWR POWER PLANTS

	UNIT SIZE RANGE MW(E) 700-1500			
	NO. UNITS PER SITE			
	1	2	3	4
PLANT MANAGER'S OFFICE				
MANAGER	1	1	1	1
ASSISTANT	1	2	3	4
QUALITY ASSURANCE	3	4	5	6
ENVIRONMENTAL CONTROL	1	1	1	1
PUBLIC RELATIONS	1	1	1	1
TRAINING	1	1	2	2
SAFETY	1	1	1	1
ADMIN. & SERVICES	13	15	17	19
HEALTH SERVICES	1	1	1	2
SECURITY	56	56	56	66
SUBTOTAL	79	83	88	103
OPERATIONS				
SUPERVISION (EXC. SHIFT)	2	2	4	4
SHIFTS	33	58	83	108
SUBTOTAL	35	60	87	112
MAINTENANCE				
SUPERVISION	8	8	10	12
CRAFTS	16	26	36	46
PEAK MAINT. ANNUALIZED	36	72	118	154
SUBTOTAL	60	106	164	212
TECHNICAL AND ENGINEERING				
REACTOR	1	2	3	4
RADIO-CHEMICAL	2	2	3	4
I & C	2	2	3	4
PERFORM., REPORTS, TECH.	17	21	25	29
SUBTOTAL	22	27	34	41
TOTAL	196	276	373	468
LESS SECURITY	140	220	317	402
LESS SEC., PEAK MAINT	104	148	199	248

TABLE 7-16
ENERGY ECONOMIC DATA BASE
(Constant $1978)

Effective Date - 1/1/78

STAFF REQUIREMENT FOR GCFR POWER PLANTS

	UNIT SIZE RANGE MW(E) 700-1500 NO. UNITS PER SITE 1	2	3	4
PLANT MANAGER'S OFFICE				
MANAGER	1	1	1	1
ASSISTANT	1	2	3	4
QUALITY ASSURANCE	3	4	5	6
ENVIRONMENTAL CONTROL	1	1	1	1
PUBLIC RELATIONS	1	1	1	1
TRAINING	1	1	2	2
SAFETY	1	1	1	1
ADMIN. & SERVICES	13	15	17	19
HEALTH SERVICES	1	1	1	2
SECURITY	66	66	66	76
SUBTOTAL	89	93	98	113
OPERATIONS				
SUPERVISION (EXC. SHIFT)	2	2	4	4
SHIFTS	33	58	83	108
SUBTOTAL	35	60	87	112
MAINTENANCE				
SUPERVISION	8	8	10	12
CRAFTS	16	26	36	46
PEAK MAINT. ANNUALIZED	55	110	165	220
SUBTOTAL	79	144	211	278
TECHNICAL AND ENGINEERING				
REACTOR	1	2	3	4
RADIO-CHEMICAL	2	2	3	4
I & C	2	2	3	4
PERFORM., REPORTS, TECH.	17	21	25	29
SUBTOTAL	22	27	34	41
TOTAL	225	324	430	544
LESS SECURITY	159	258	364	468
LESS SEC., PEAK MAINT	104	148	199	248

TABLE 7-17
ENERGY ECONOMIC DATA BASE
(Constant $1978)

Effective Date - 1/1/78

STAFF REQUIREMENT FOR LMFBR POWER PLANTS

	UNIT SIZE RANGE MW(E) 700-1500			
	NO. UNITS PER SITE			
	1	2	3	4
PLANT MANAGER'S OFFICE				
MANAGER	1	1	1	1
ASSISTANT	1	2	3	4
QUALITY ASSURANCE	3	4	5	6
ENVIRONMENTAL CONTROL	1	1	1	1
PUBLIC RELATIONS	1	1	1	1
TRAINING	1	1	2	2
SAFETY	1	1	1	1
ADMIN. & SERVICES	13	15	17	19
HEALTH SERVICES	1	1	1	2
SECURITY	66	66	66	76
SUBTOTAL	89	93	98	113
OPERATIONS				
SUPERVISION (EXC. SHIFT)	2	2	4	4
SHIFTS	33	58	83	108
SUBTOTAL	35	60	87	112
MAINTENANCE				
SUPERVISION	8	8	10	12
CRAFTS	16	26	36	46
PEAK MAINT. ANNUALIZED	55	110	165	220
SUBTOTAL	79	144	211	278
TECHNICAL AND ENGINEERING				
REACTOR	1	2	3	4
RADIO-CHEMICAL	2	2	3	4
I & C	2	2	3	4
PERFORM., REPORTS, TECH.	17	21	25	29
SUBTOTAL	22	27	34	41
TOTAL	225	324	430	544
LESS SECURITY	159	258	364	468
LESS SEC., PEAK MAINT	104	148	199	248

TABLE 7-18
ENERGY ECONOMIC DATA BASE
(Constant $1978)

Effective Date - 1/1/78

STAFF REQUIREMENT FOR COAL-FIRED POWER PLANTS WITH FGD SYSTEMS

	UNIT SIZE RANGE MW(E)							
	400-700				701-1300			
	NO. UNITS PER SITE				NO. UNITS PER SITE			
	1	2	3	4	1	2	3	4
PLANT MANAGER'S OFFICE								
MANAGER	1	1	1	1	1	1	1	1
ASSISTANT	1	2	3	4	1	2	3	4
ENVIRONMENTAL CONTROL	1	1	1	1	1	1	1	1
PUBLIC RELATIONS	1	1	1	1	1	1	1	1
TRAINING	1	1	1	1	1	1	1	1
SAFETY	1	1	1	1	1	1	1	1
ADMIN. & SERVICES	13	14	15	16	13	14	15	16
HEALTH SERVICES	1	1	1	2	1	1	1	2
SECURITY	7	7	9	14	7	7	9	14
SUBTOTAL	27	29	33	41	27	29	33	41
OPERATIONS								
SUPERVISION (EXC. SHIFT)	3	3	5	5	3	3	5	5
SHIFTS	45	50	60	65	45	50	60	65
FUEL AND LIMESTONE REC.	12	12	12	18	12	12	12	18
WASTE SYSTEMS	15	30	45	60	15	30	45	60
SUBTOTAL	75	95	122	148	75	95	122	148
MAINTENANCE								
SUPERVISION	8	8	10	12	8	8	10	12
CRAFTS	90	115	135	155	95	120	140	160
PEAK MAINT. ANNUALIZED	33	66	99	132	35	70	105	140
SUBTOTAL	131	189	244	299	138	198	255	312
TECHNICAL AND ENGINEERING								
WASTE	1	2	3	4	1	2	3	4
RADIO-CHEMICAL	2	2	3	4	2	2	3	4
I & C	2	2	3	4	2	2	3	4
PERFORM., REPORTS, TECH.	14	17	21	24	14	17	21	24
SUBTOTAL	19	23	30	36	19	23	30	36
TOTAL	252	336	429	524	259	345	440	537

TABLE 7-19
ENERGY ECONOMIC DATA BASE
(Constant $1978)

Effective Date - 1/1/78

STAFF REQUIREMENT FOR COAL-FIRED POWER PLANTS WITHOUT FGD SYSTEMS

	UNIT SIZE RANGE MW(E)							
	400-700				701-1300			
	NO. UNITS PER SITE				NO. UNITS PER SITE			
	1	2	3	4	1	2	3	4
PLANT MANAGER'S OFFICE								
MANAGER	1	1	1	1	1	1	1	1
ASSISTANT	1	2	3	4	1	2	3	4
ENVIRONMENTAL CONTROL	1	1	1	1	1	1	1	1
PUBLIC RELATIONS	1	1	1	1	1	1	1	1
TRAINING	1	1	1	1	1	1	1	1
SAFETY	1	1	1	1	1	1	1	1
ADMIN. & SERVICES	12	13	14	15	12	13	14	15
HEALTH SERVICES	1	1	1	2	1	1	1	2
SECURITY	7	7	9	14	7	7	9	14
SUBTOTAL	26	28	32	40	26	28	32	40
OPERATIONS								
SUPERVISION (EXC. SHIFT)	2	2	4	4	2	2	4	4
SHIFTS	45	50	60	65	45	50	60	65
FUEL HANDLING	12	12	12	18	12	12	12	18
SUBTOTAL	59	64	76	87	59	64	76	87
MAINTENANCE								
SUPERVISION	6	6	8	10	6	6	8	10
CRAFTS	75	90	100	110	80	95	105	115
PEAK MAINT. ANNUALIZED	32	64	96	128	32	64	96	128
SUBTOTAL	113	160	204	248	118	165	209	253
TECHNICAL AND ENGINEERING								
RADIO-CHEMICAL	2	2	3	4	2	2	3	4
I & C	2	2	3	4	2	2	3	4
PERFORM., REPORTS, TECH.	12	15	18	21	15	18	21	24
SUBTOTAL	16	19	24	29	19	22	27	32
TOTAL	214	271	336	404	222	279	344	412

SECTION 8

8.1 REFERENCES AND BIBLIOGRAPHY

1. "Commercial Electric Power Cost Studies," United Engineers & Constructors Inc., Philadelphia, PA 19101, NUREG: U.S. Nuclear Regulatory Commission and/or COO: U.S. Energy Research and Development Administration.

    a. "Capital Cost: Pressurized Water Reactor Plant," Volumes 1 and 2, NUREG-0241, COO-2477-5, June 1977.

    b. "Capital Cost: Boiling Water Reactor Plant," Volumes 1 and 2, NUREG-0242, COO-2477-6, June 1977.

    c. "Capital Cost: High and Low Sulfur Coal Plants - 1200 MWe (Nominal)," Volumes 1, 2 and 3, NUREG-0243, COO-2477-7, June 1977.

    d. "Capital Cost: Low and High Sulfur Coal Plants - 800 MWe (Nominal)," Volumes 1, 2 and 3, NUREG-0244, COO-2477-8, June 1977.

    e. "Capital Cost Addendum: Multi-Unit Coal and Nuclear Stations," Volume 1, NUREG-0245, COO-2477-9, June 1977.

    f. "Fuel Supply Investment Cost: Coal and Nuclear," Volume 1, NUREG-0246, COO-2477-10, April 1979.

    g. "Cooling Systems Addendum: Capital and Total Generating Cost Studies," Volume 1, NUREG-0247, COO-2477-11, September 1978.

    h. "Total Generating Costs: Coal and Nuclear Plants," Volume 1, NUREG-0248, COO-2477-12, February 1979.

    i. "Capital Cost: Pressurized Heavy Water Reactor Plant," Volumes 1 and 2, COO-2477-13, June 1977.

    j. "Capital Cost: Gas Cooled Fast Reactor Plant," Volume 1, COO-2477-16, September 1977.

2. "NSSS Capital Costs for a Mature LMFBR Industry for Energy Economic Data Base Program-Phase I," Combustion Engineering, Inc., Windsor, CT 06095, CE-FBR-78-532, United Engineers & Constructors Inc. Subcontract, October 1978. (Refer to Appendix D-1)

3. "3360 MWt HTGR-Steam Cycle Reference Plant Design," United Engineers & Constructors Inc., Philadelphia, PA 19101, Volumes I through X, General Atomic Company Subcontract SC558623 Proprietary, August 1977.

4. "Study of Electric Plant Applications for Low Btu Gasification of Coal for Electric Power Generation," Combustion Engineering, Inc., Windsor, CT 06905, U.S. Department of Energy Contract FE-1545-TK59.

5. "Final Report on Nuclear Fuel Cycle Consulting Services for Energy Economic Data Base Program-Phase I," NUS Corporation, Rockville, MD 20850, NUS-3273 (Proprietary), United Engineers & Constructors Inc. Subcontract, October 1978. (Refer to Appendix B)

    a. "Fuel Cycle Cost Estimates for LWR, HTGR, CANDU Type HWR, LMFBR and GCFR," NUS-3190.

    b. "Cost of Enrichment Services," NUS-3196.

    c. "UF_6 Conversion Cost," NUS-3198.

    d. "Heavy Water Production Costs," NUS-3199.

    e. "Spent Fuel and Reprocessing Waste Disposition," NUS-3203.

    f. "Costs for Spent Fuel Shipping," NUS-3204.

    g. "HTGR Fuel Cycle," NUS-3207.

    h. "Costs of U_3O_8," NUS-3209.

    i. "A Survey of Fuel Costs for U.S. Nuclear Power 1973-1977," NUS-3223.

    j. "Reprocessing Cost Model for LWR, LMFBR and GCFR," NUS-3224.

    k. "Recommendations Relating to Acquisition of Mass Flow Data for the EEDB Program," NUS-3237.

    l. "Fabrication Costs for 'Rodded' Nuclear Fuels," NUS-3242.

    m. "Recommendations Relating to Evaluation of Nuclear Fuel Unit-Cost Data for EEDB Program," NUS-3243.

    n. "Additional Fuel Cost Studies - Escalation, 2001 Startup and CANDU Thorium System," NUS-3244.

6. Messing, R. F. and Harris, H. E.: "Comparative Energy Values to 1990," Report No. R770602, Impact Securities Corp., (Subsidiary), Arthur D. Little, Inc., Cambridge, MA 02140, June 1977.

7. Browne, Thomas E., et al. (Seven Authors): "Supply 77-EPRI Annual Energy Supply Forecasts," Report No. EA-634-SR, Electric Power Research Institute, Palo Alto, CA 94304, May 1978.

8. Private Communication - "Estimates of Baseline Delivered Coal Costs," (PWC Job No. 3592), Paul Weir Co., 20 North Wacker Drive, Chicago, IL 60606, October 13, 1978.

9. Private Communication - "Average Steam Coal Prices and Transportation Costs for Two Hypothetical Plant Sites," Internal Memorandum, United Engineers & Constructors Inc., Philadelphia, PA 19101, Job No. 6740.030, C. M. Valorie to A. J. Karalis, August 22, 1978.

10. Monthly Energy Review, U.S. Department of Energy, Energy Information Administration, Washington, DC 20461 (Monthly Through June 1979).

11. Myers, M. C., Fuller, L. C., "A Procedure for Estimating Non-Fuel Operating and Maintenance Costs for Large Steam - Electric Power Plants," Oak Ridge National Laboratory, Oak Ridge, TN 37830, ORNL/TM-6467, January 1979.

12. Myers, M. C., "Guidelines for Estimating Non-Fuel Operation and Maintenance Costs for Alternative Nuclear Power Plants," Oak Ridge National Laboratory, Oak Ridge, TN 37830, ORNL/TM-6860, September 1979.

13. "Final Report and Initial Update of the Energy Economic Data Base (EEDB) Program (Phase I)," United Engineers & Constructors Inc., Philadelphia, PA 19101, U.S. Department of Energy Contract EN-78-C-4954, December 1979.

14. Phung, Doan L., Perry, Alfred M., Whittle, Charles E., "Economics of Coal and Nuclear Electricity - A Treatment of Inflation and Differential Cost Increases," Volume 39, pp 407-415, Proceedings of the American Power Conference, 1977.

15. Stauffer, T. R., Palmer, R. S., Wyckoff, H. L., "Breeder Reactor Economics," Unnumbered: Breeder Reactor Corporation, July 1975.

16. Roberts, J. O., Davis, S. M., Nash, D. A., "Coal and Nuclear: A Comparison of the Cost of Generating Baseload Electricity by Region," NUREG-0480: U.S. Nuclear Regulatory Commission, December 1978.

17. "Engineering Economics, A Manager's Guide to Economic Decision Making," Third Edition, American Telephone and Telegraph Company, 1977.

18. Crowley, J. H., et al, "The Need for and Deployment of Inexhaustible Energy Resource Technologies," Report of Technology Study Panel Inexhaustible Energy Resources Study by United Engineers & Constructors Inc., Philadelphia, PA 19101, Unnumbered Report: U.S. Energy Research and Development Administration, September 1977.

8.2 GLOSSARY OF ACRONYMS AND ABBREVIATIONS

8.2.1 Governmental Organizations

AEC	-	Atomic Energy Commission (Succeeded first by ERDA and then by DOE)
ANL	-	Argonne National Laboratory
BNL	-	Brookhaven National Laboratory
COO	-	Chicago Operations Office - DOE
DOD (DoD)	-	Department of Defense
DOE (DoE)	-	Department of Energy (Successor to ERDA and AEC)
DOI	-	Department of the Interior
EIA	-	Energy Information Administration
EPA	-	Environmental Protection Agency
ERDA	-	Energy Research and Development Administration (Succeeded AEC and was then superseded by DOE)
FEA	-	Federal Energy Administration
FERC	-	Federal Energy Regulatory Commission
HEDL	-	Hanford Engineering Development Laboratory
LASL	-	Los Alamos Scientific Laboratory
LLL	-	Lawrence Livermore Laboratory
NRC	-	Nuclear Regulatory Commission
ORNL	-	Oak Ridge National Laboratory
SC	-	Sandia Corporation
SL	-	Sandia Laboratories
US	-	United States

8.2.2 Other Organizations

ADL - Arthur D. Little, Inc.

ASTM - American Society for Testing Materials

CE - Combustion Engineering, Inc.

EEI - Edison Electric Institute

EPRI - Electric Power Research Institute

GAC - General Atomic Company

GE - General Electric Company

NUS - NUS Corporation
(Formerly Nuclear Utility Services Corporation)

UE&C - United Engineers & Constructors Inc.
(A Raytheon Subsidiary)

UMW - United Mine Workers

WE
WECo - Westinghouse Electric Corporation

8.2.3 Technical Identification and Programs

BBL - Barrels

bbl/d - Barrels per day

BOP - Balance of Plant

Btu
BTU - British Thermal Unit
= 1055 Joules

BWR - Boiling Water Reactor

C - Temperature - Degrees Celsius
(sometimes - incorrectly - Centigrade)

CANDU - CANadian Deuterium Uranium
(Alternate designation for PHWR)

CAP - Net Electrical Capacity

CF - Capacity Factor

CGCC - Coal Gasification Combined Cycle plant

CLIQ - Coal Liquefaction plant

CO - Carbon Monoxide

CO_2 - Carbon Dioxide

CONCICE - CONceptual Construction Investment Cost Estimate - UE&C Proprietary Code

COS - Carbonyl Sulfide - Carbon Oxysulfide

CPGS - Comparison Power Generating Station

CRBR - Clinch River Breeder Reactor

CY
cy - Calendar Year

CY - Cubic Yard - yd^3

e_i - Escalation rate for money inflation - %/y

e_s - Escalation rate for scarcity - reduced productivity - %/y

EBR - Experimental Breeder Reactor
(Two versions: -I and -II)

EEDB - Energy Economic Data Base

EHS - Eastern High Sulfur Coal

F - Temperature - Degrees Fahrenheit

FBR - Fast Breeder Reactor

FCR - Fixed Charge Rate

FGD - Flue Gas De-Sulfurization

FIT - Federal Income Tax

FPGS - Fossil Powered (Electrical) Generating Station

FUELCOST-V - A NUS proprietary code

FY
fy - Fiscal Year

GCFR - Gas Cooled Fast (Breeder) Reactor
(Sometimes GCFBR)

GCR - Gas Cooled Reactor - general designation for all gas-cooled reactor systems

GESSAR - General Electric Standard Safety Analysis Report

GSU - Generator Step-Up Transformer

GW - Gigawatt = 10^9 Watts

h - Hour

HLW - High Level Waste (Radioactive)

HM - Heavy Metal - fuels containing mixtures of
U + Pu, U + Th, Pu + Th

HP - Horse Power - 1000 HP and up

hr - Hour

HR - Net Station Heat Rate in Btu/kWh

HS - High Sulfur ($\geq$ 1.0%)

HSC - High Sulfur Coal

HS8 - High Sulfur (Coal-Fired) 800 MWe Plant

HS12 - High Sulfur 1200 MWe Coal-Fired Plant

HTGR - High Temperature Gas (Cooled) Reactor

H_2S - Hydrogen Sulfide

HWR - Heavy Water Reactor

I&C - Instrumentation and Control

in HgA - Inches of Mercury Pressure - Absolute
= 25.4 Torr

kgH
kgHM - Kilograms Heavy Metal

kgU - Kilograms Uranium

kV - Volts x 10^3 - Kilovolts

kVA - Volt Amperes x 10^3 - Kilovolt-Amperes

kW - Kilowatt - 10^3 Watts = 3414 Btu/hr

kWh - Kilowatt-Hour - 3414 Btu

LB (lb.) - Pound(s)

LF - Linear Feet

LF - Levelization Factor

LMFBR - Liquid Metal Fast Breeder Reactor

LS - Low Sulfur ($\leq$ 1.0%)

LS8 - Low Sulfur (Coal-Fired) 800 MWe
Electrical Generating Station

LS12 - Low Sulfur (Coal-Fired) 1200 MWe
Electrical Generating Station

LT - Lot

LWR - Light Water Reactor (includes BWR and PWR) m - Minute

¢/MBtu - Cents per Btu x 10^6

$/MBtu - Dollars per Btu x 10^6

min - Minute

m/kWh - Mills per Kilowatt Hour - $ x 10^{-3} per kWh

mm Hg - Millimeter of Mercury Pressure

MOX - Mixed Oxide Fuel - Mixed UO_2 - PuO_2 Fuel

MT - Metric Tons - 2205 Pounds

MTH
MTHM - Metric Tons of Heavy Metal - HM

MTU - Metric Tons of Uranium

MVA - Volt Amperes x 10^6

MW - Megawatt = 10^6 Watts

MWd/MT - Megawatt-Days per Metric Ton

MWD/T - Megawatt - Days per Ton

MWe - MegaWatts (Watts x 10^6) - Electrical

MWt - MegaWatts (Watts x 10^6) - Thermal

Na - Element No. 11 - Sodium
- Liquid Metal Coolant

NaK - Sodium/Potassium - Liquid Metal Coolant Mixture

NASAP - Nonproliferation Alternative Systems Assessment Program

NASAP Codes
- o (DE) - Denatured (U-233/U-235 mixed with U-238)
- o (HE) - High Enrichment
- o (LE) - Low Enrichment (in U-235)
- o (ME) - Medium Enrichment

NASAP Codes (continued)

- (NAT) - Natural Uranium - 0.7 w/o U-235
- Pu - Plutonium (Fissile Pu)
- RE - Reprocess
- T - Throwaway
- Th - Thorium
- 20% - 20 Weight Percent U-235
- U - Uranium
- U5 - Uranium-235
- U3 - Uranium-233

NNS - Non-Nuclear Safety Grade Pipe

Np - Element No. 93, Neptunium - Does not occur in nature - intermediate in formation of Pu-239

NPGS - Nuclear Powered (Electrical) Generating Station

NS - Nuclear Safety Grade Pipe

O&M - Operation and Maintenance

OMCOST - An ORNL code for Operation and Maintenance costs

Pa - Element No. 91 - Protactinium

PEGASUS - Power Plant Economic Generator And Scale-Up System - UE&C Proprietary Code

PHS - Pittsburgh High Sulfur (Steam) Coal

PHWR - Pressurized Heavy Water Reactor (Sometimes - CANDU)

PLBR - Prototype Large Breeder Reactor

PSI (psi) - Pounds per Square Inch

PSIA (psia) - Pounds per Square Inch - Absolute

PSIG (psig) - Pounds per Square Inch - Gauge (14.7 psia = 0 psig)

Pu - Element No. 94 - Plutonium - Does not occur in nature; two isotopes thermally fissile Pu-239, Pu-241

PuO_2 - Plutonium Dioxide

Pu_2O_3 - Plutonium Sesquioxide

Pu-241
Pu-239 - Thermally Fissile Isotopes of Pu produced by neutron capture in U-238

PWR - Pressurized Water Reactor

QA - Quality Assurance

QC - Quality Control

r
rev - Revolutions

RESAR-35 - Westinghouse Reference Safety Analysis Report

ROI - Return on Investment

RPCW - Reactor Plant Cooling Water

RPM
r/m - Revolutions per Minute

s - Second

SCF - Standard Cubic Feet - one cubic foot of gas at 0^oC and 760 Torr

SCFD
SCF/D
scf/d - Standard Cubic Feet (per) Day (Also SCFM (per minute) and SCFH (per hour) @ 760 Torr and 0^oC)

sec - Second

SF - Square Feet - ft^2

SO_2 - Sulfur Dioxide

SRC - Solvent Refined Coal

ST - Tons - a short ton = 2000 pounds

SWU - Separative Work Unit - for Uranium Enrichment

TEC - Thermal Energy Costs

Th - Element No. 90, Thorium - fertile ^{232}Th or Th-232 - the naturally occurring Th isotope ~100% abundance

TM-xxxx - Technical Memorandum

\$/t-mi - Dollars per Ton Mile (coal transportation)

TN - Ton(s) - A short ton = 2000 pounds

Torr - Torricelli - 1 mm mercury 760 Torr = 1 atmosphere = 14.7 pounds/in.^{2}

U - Element No. 92 - Uranium

UC - Uranium Monocarbide (also uranium carbide)

UC_2 - Uranium Dicarbide

U_2C_3 - Uranium Sesquioxide

UF_6 - Uranium Hexafloride (Gas)

UO_2 - Uranium Dioxide - Fuel

U_3O_8 - Triuranium Octoxide - Raw Uranium Oxide Yellowcake - Uranium Oxide

U-233 - Thermally Fissile Isotope of Uranium produced by neutron irradiation of Th-232

U-235 - Thermally Fissile Isotope of Uranium; only naturally occurring fissile element - abundance ~ 0.7%

U-238 - Not Thermally Fissile Isotope of Uranium; most abundant naturally occurring, abundance ~ 99.3%; fertile target for production of thermally fissile Pu-239

WATT - Btu/HR x 3.41443
WATT/HR = Btu

W(e) - Watts - Electrical

W(t) - Watts - Thermal

WLS - Western High Sulfur Coal

y
yr - Year = 8760 Hours = 3.154×10^7 sec.