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Phase VI Update (1983) Report For The Energy Economic Data Base Program

EEDB - VI

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Prepared for:
U.S. Department of Energy
Assistant Secretary for Nuclear Energy
Office of Support Programs
Plans and Evaluation Division

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Prepared for:
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Assistant Secretary for Nuclear Energy
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Plans and Evaluation Division
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CONTENTS

ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
PHASE VI UPDATE (1983) REPORT

CONTENTS

ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
PHASE VI UPDATE (1983) REPORT (cont'd)

CONTENTS

ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
PHASE VI UPDATE (1983) REPORT (cont'd)

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ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
PHASE VI UPDATE (1983) REPORT

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TABLE LIST

ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
PHASE VI UPDATE (1983) REPORT

TABLE LIST (cont'd)

TABLE LIST (cont'd)

TABLE LIST (cont'd)

FIGURE LIST

ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
PHASE VI UPDATE (1983) REPORT

EXECUTIVE SUMMARY OF THE ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM PHASE VI UPDATE (1983) REPORT

DESCRIPTION OF THE ENERGY ECONOMIC DATA BASE PROGRAM

The objective of the Energy Economic Data Base (EEDB) Program is to provide periodic updates of power plant technical and cost information to the U.S. Department of Energy (DOE), in support of program planning by the Office of the Assistant Secretary for Nuclear Energy.

Historical Basis

This update of the Energy Economic Data Base is the latest in a series of technical and cost studies prepared by United Engineers & Constructors Inc., during the last 18 years. These studies have been sponsored by the U.S. Department of Energy, the U.S. Nuclear Regulatory Commission and their predecessor organizations, the U.S. Energy Research and Development Administration, and the U.S. Atomic Energy Commission. The EEDB and its antecedent studies provide a common and consistent detailed basis for evaluating and comparing the economic viability of a variety of nuclear and alternative power generating stations.

The data base was developed during 1978 and has been updated annually since then. The purpose of the updates has been to reflect the impact of changing regulations and technology on the costs of electric power generating stations. This Phase VI (Sixth) Update Report documents the results of the 1983 EEDB Program update effort. The latest effort was a comprehensive update of the technical and capital cost information for the pressurized water reactor, boiling water reactor, and liquid metal fast breeder reactor nuclear power plant data models and for the 800 MWe and 500 MWe high sulfur coal-fired power plant data models. The update provided representative costs for these nuclear and coal-fired power plants for the 1980's. In addition, the updated nuclear power plant data models for the 1980's were modified to provide anticipated costs for nuclear power plants for the 1990's. Consequently, the Phase VI Update has continued to provide important benchmark information through which technical and capital cost trends may be identified that have occurred since January 1, 1978.

Power Plant Cost Trends and The EEDB Program

The EEDB updates regularly estimate current capital costs of power plants based on conditions as they exist on the cost and regulation date of each update. That is, they incorporate current regulatory requirements, construction and management practices, labor productivity, and labor/material costs. Capital costs are developed in terms of direct and indirect base construction costs. The direct costs are the costs of commodities, equipment and their installation labor. Indirect costs are the costs of construction services, engineering, construction management, field supervision and testing.

The 1983 and the preceding five EEDB Updates have identified a continuing upward trend in light water reactor power plant costs, relative to those of coal-fired power plants. The principal drivers behind this trend have been increases caused by sharp rises in the quantities of commodities, construction labor manhours, and engineering and construction supervision manhours. However, labor costs have become the predominant cost driver in the Phase VI Update. In this update,

the rise in all of the indirect costs, particularly construction supervision, was much greater than the rise in direct costs, which did not significantly exceed the average inflation rate.

Recent EEDB updates have developed nuclear power plant costs that are representative of median industry experience during the 1980's. However, two important trends that have emerged indicate that nuclear power plant base construction costs are rising twice as fast as inflation and the end points of the total range of these costs are rapidly diverging. The effects of these trends is to cause the median cost experience to mask the better cost achievements. Consequently, the Phase VI Update has also developed projected costs for nuclear units for the 1990's that are based on current best experience and reflect the potential effects of proposed improved construction practices and nuclear regulatory and licensing reforms.

Continuing increases in nuclear power plant base construction costs are not in themselves a new development. Nevertheless, through the use of this information, the EEDB has become an important tool in identifying those cost elements that have been most susceptible to change, and the factors that have been dominant in causing their change. This kind of information may provide a basis for identifying and developing corrective measures that permit nuclear energy to continue as a competitive source of electric power.

Data Base Content

The data base currently contains technical and capital (base construction) cost data models for 14 different types of nuclear and comparison power generating stations. The 14 power plant models included in the data base are listed below. Those models that were updated in the Phase VI Update are marked with a "VI."

Nuclear Power Generating Stations

VI 1200 MWe Boiling Water Reactor Plant (BWR)
900 MWe High Temperature Gas Cooled Reactor Plant - Steam Cycle (HTGR-SC)
VI 1150 MWe Pressurized Water Reactor Plant (PWR)
1300 MWe Pressurized Heavy Water Reactor Plant (PHWR)
VI 1500 MWe Liquid Metal Fast Breeder Reactor Plant (LMFBR)
1200 MWt High Temperature Gas Cooled Reactor Plant - Process Steam (HTGR-PS)

Comparison Fossil Power Generating Stations

1200 MWe High Sulfur Coal Plant (HS12)
VI 800 MWe High Sulfur Coal Plant (HS8)
1200 MWe Low Sulfur Coal Plant (LS12)
800 MWe Low Sulfur Coal Plant (LS8)
650 MWe Coal Gasification Combined Cycle Plant (CGCC)
VI 500 MWe High Sulfur Coal Plant (HS5)
500 MWe Low Sulfur Coal Plant (LS5)
500 MWe Low Sulfur Coal Plant - District Heating (LS5-D/H)

In the EEDB, the terms "capital cost" and "base construction cost" are used interchangeably. EEDB base construction costs are in current dollars and contain no arbitrary factors, such as contingency or escalation. In actual practice, total capital costs are the sum of the base construction costs and a number of other factors, such as owner's costs, contingency, escalation and allowance for funds used during construction.

Perhaps the most important attribute of any EEDB update is the fact that assumptions and ground rules are clearly identified and are applied uniformly to all cost estimates. Site related factors are normalized by locating each technical model on a common hypothetical "Middletown" site, for which there is a detailed geological and environmental description.

Technical/Cost Data Models

Each capital cost estimate is based upon a detailed technical data model which includes system design descriptions for over 50 major structure/systems and up to 400 subsystems, a detailed equipment list containing up to 1250 mini-specifications and up to 10,000 data lines of commodity, equipment and labor hour quantities and costs. The technical data models are based on actual current power plant designs and over 50 years of power plant design and construction experience. The data models have sufficient visibility of details and assumptions that the user may have confidence in the consistency, balance and comparability of the various alternatives contained in the data base.

EEDB Program Estimating Approach

The EEDB estimating approach promotes understanding and acceptance of reported costs, because all components of "bottom-line" amounts in the different estimates are readily identified and compared through a uniform accounting system. For example, base construction costs are presented as equipment, labor, and site material costs in a uniform code-of-accounts. Each system, component or commodity that is common to two or more of the technical models has the same account identifier in every model. This feature, together with the high level of detail furnished, is the means by which a consistent comparison of commodities, components and manhours is accomplished among diverse alternatives. Where comparisons are made of bottom-line base construction costs, individual account per-unit costs and per-unit manhours may be compared as credibility checks. The cost and commodity/manhour tabulations may also be used as a guide to determine what is included in external estimates where ground rules, assumptions or details are unavailable.

SUMMARY OF THE PHASE VI UPDATE TECHNICAL CHANGES

Major Activities

Selection of technical/cost data models to be included in a given update are based on current DOE objectives and availability of resources. During the Phase VI Update, the following major activities were completed:

- Phase V (1982) PWR, BWR, LMFBR, HS8 and HS5 technical data models were updated for the 1980's to January 1, 1983, with particular emphasis on structural, piping and electrical materials/equipment, craft, engineering and field service manhours, and construction services materials and manhours.

- PWR, BWR and LMFBR technical data models updated for the 1980's were modified at the nine-digit (components) code-of-accounts level of detail to reflect design features and manhours anticipated for nuclear power plants for the 1990's.

- The HS5 technical data model was developed from the three-digit (systems) to the nine-digit code-of-accounts level of detail.

- An HS5 twin unit station technical data model was developed at the three-digit code-of-accounts level of detail based on the updated HS5 technical data model.

- An EEDB Technical Reference Book was developed to provide system design descriptions at the three-digit code-of-accounts level of detail for the PWR, BWR, LMFBR, HS8 and HS5 technical data models.

Phase VI Technical Update Process

Field surveys, conducted in parallel with the Phase VI Update, confirmed that nuclear power plant costs continued to escalate at a rate that was twice that of inflation, but also showed that craft labor, engineering and field supervision were becoming the predominant drivers in nuclear power plant costs. The surveys showed that nuclear power plant base construction costs and labor manhours were diverging sharply between the best and poorest cost experience units. Table ES-1 summarizes the survey data for large PWR power plants that were under construction and more than 60 percent complete in January, 1983.

An in-depth review was performed on the PWR and HS8 to adjust their technical data models against current construction experience, as represented by the field surveys, other appropriate studies and United Engineers' current experience. Adjustments were made to quantities of commodities, equipment and manhours based on the benchmarks established from the median industry experience data. The adjustments were made to each technical data model's structures/systems at the nine-digit code-of-accounts level of detail. After these adjustments were made, the PWR and HS8 technical data models' total quantities of commodities and manhours were found to be in agreement with the median industry experience and, therefore, representative of current industry practice. The PWR and HS8 adjustments were used as the basis to make changes in the other nuclear and coal-fired power plant technical data models which were updated for Phase VI, in order to correlate these models with current practice.

Because of the trends mentioned above, the median industry cost experience has become less representative of the better nuclear power plant cost experience.

Therefore, modifications were made to the updated Phase VI nuclear power plant technical data models (for the 1980's) to support cost estimates that were more representative of commercially viable systems anticipated for the 1990's. The modified technical data models were based on the current best (but not lowest) industry cost and manhours experience and the assumption that regulatory reforms and improved construction practices would be promulgated and implemented.

A small multi-unit coal-fired power station technical data model was developed for use in cost comparisons with large nuclear power plants. The twin-unit design was based on a "first-of-two" and a "second-of-two" modification of the HS5. The data model supported cost savings derived from shared systems, multiple equipment purchase, concurrent engineering and a construction labor learning curve.

A variety of refinements were made to the nuclear and coal-fired technical data models; however, the economic impact to each data model was small. The most significant refinement was a revision to the HS8 coal handling system. The system was changed from a lowering-well/rotary-plow design to a stacker/reclaimer system that was more suitable for the "Middletown" hard-rock site. (Descriptions of the hypothetical "Middletown" site may be found in the EEDB Program Reference Book.)

A technical reference book was prepared during the Phase VI Update. It contained conceptual system design descriptions for the 50 major structures and systems for each of the nuclear and coal-fired power plants updated in Phase VI. The descriptions were supported with tabulations of key technical parameters, plot plans and summary heat balance diagrams.

The adjustments described above comprise a major update to the EEDB PWR, BWR, LMFBR, HS8 and HS5 technical data models. An important result of the effort is that the EEDB technical features and resulting capital cost estimates are currently reflective of nuclear and coal-fired power plant construction experience. Consequently, the data base is available to serve as a current benchmark for identifying trends in quantities of commodities, equipment and manhours and their related costs for these types of power plants.

RESULTS OF THE PHASE VI UPDATE COST CHANGES

Summary of the Cost Results

The Phase V (1982) base construction costs were recalculated during the Phase VI Update based on updated pricing information and the adjusted and revised technical data models described above. Updated equipment prices were obtained from manufacturers of major equipment. Commodity unit costs and labor rates were revised, in accordance with national indices and United Engineers' project experience. Quantities of commodities and manhours per unit of commodity/equipment were derived from the updated technical data models.

A summary of the Phase VI Update base construction cost results is given in Table ES-2. All costs are given in January 1, 1983 constant dollars and include

the consequences of safety and environmental regulations in effect on that date. The table illustrates the cost differences between nuclear power plants for the 1980's and those anticipated for the 1990's and between single and twin unit coal-fired power plants.

The base construction or capital costs (direct + indirect costs) exclude owner's costs, contingency, fixed charges, escalation and allowance for funds used during construction. The nuclear power plant costs include the effects of design features that resulted from the Three Mile Island incident. The coal-fired power plant costs include costs for enclosed boilers and turbine-generators, electrostatic precipitators and wet lime flue gas desulfurization systems (scrubbers). Both nuclear and coal-fired power plants include costs for mechanical draft cooling towers, river water makeup and treatment of waste water discharge.

Summary of Cost Changes

An overview of the EEDB cost changes, that have occurred between the Phase I Update in 1978 and the Phase VI Update in 1983, is given in Table ES-3. All of the values in Table ES-3 are given in 1983 constant dollars to remove the effects of inflation. This table shows that the EEDB nuclear power plants for the 1980's (median industry cost experience) have experienced significant real base construction cost increases between 1978 and 1983, relative to those experienced by the HS8. On the other hand, Table ES-4 shows that the cost increases for the nuclear power plants for the 1990's (best industry cost experience) are similar to those experienced by the HS8. The median experience PWR has more than doubled in cost between 1978 and 1983, while the best experience PWR and the HS8 costs have increased by about 25 percent each. Of the increase for the median experience PWR, over 25 percent occurred between the Phase V and Phase VI Updates, while the HS8 remained relatively constant in cost for these two updates.

The cost changes for the PWR's from 1978 through 1983 have been driven by the increases in commodities and manhours discussed above, particularly in the case of the median experience PWR. During the Phase VI Update, the large increase in manhours for the median experience PWR was primarily responsible for the large increase in the PWR cost. The cost change for the HS8 from 1978 to 1983 was primarily caused by the increase in costs for flue gas cleaning, waste water treatment and various technical refinements; however, the major impact was caused by a near tripling of the flue gas cleaning installed costs.

Quantities and manhours for the BWR and LMFBR were changed based on the PWR changes. Therefore, the ratios of capital costs for the three nuclear options remained essentially constant, and their cost trends relative to coal-fired power plants were about the same. The BWR and LMFBR technical data models for the 1990's had cost reductions similar to those for the PWR for the 1990's.

IMPLICATIONS OF THE RESULTS OF THE PHASE VI UPDATE

Influence of Capital Cost on Nuclear/Coal Cost Comparisons

Historically, light water reactor nuclear power plants have had higher capital costs, but lower fuel cycle costs, than coal-fired power plants. On the average,

the much higher fuel costs for the coal-fired power plants have been projected to more than offset the higher capital costs of nuclear power plants, thereby permitting nuclear power plants to produce electricity at a lower cost than many coal-fired power plants over their projected life cycles.

As shown in Tables ES-3 through ES-6, the capital costs for the nuclear power plants of the 1980's are increasing at a much faster rate than for coal-fired power plants. Consequently, the nuclear power plants of the 1980's have become marginally competitive with coal-fired power plants.

Comparison of Nuclear/Coal Cost Ratios

The EEDB PWR and HS8 base construction cost comparison in Table ES-5 for the period between 1978 and 1983 shows a much faster rate of increase for the median experience PWR costs than for either the best experience PWR costs or the HS8 costs. The values in this table are given in 1983 constant dollars to remove the effects of inflation from the comparison. Table ES-5 indicates that during this period the median experience PWR base construction costs have increased at a rate of 16 percent per year above inflation, while the best experience PWR and the HS8 base construction costs have increased at rates of five percent and four percent per year above inflation respectively. The table also indicates that the indirect costs for each of the PWR's and the HS8 have increased at a faster rate than the direct costs; however, the median experience PWR increase in indirect costs is much more significant.

Table ES-5 exemplifies the nuclear and coal-fired power plant cost trends implied by the results of the Phase I through Phase VI Updates of the EEDB. The cost trends are most significant when they are used to compare the relative costs of the nuclear option (as represented by the EEDB PWR) and an alternative (as represented by the EEDB HS8). The nuclear/coal-fired power plant capital cost trends, as identified by the changes in EEDB cost ratios between 1978 and 1983, are given in Table ES-6. The EEDB 1980's-PWR/HS8 capital cost ratio has risen by 90 percentage points from 1978 to 1983. The 1990's-PWR/HS8 capital cost ratio is only ten percentage points higher than the PWR/HS8 ratio for 1978.

Capital Cost Drivers

As shown in Table ES-5, base construction costs for the EEDB 1980's nuclear power plants have increased at a rate above inflation that is four times that for the comparable EEDB coal-fired power plants. As shown in Table ES-6 the 1980's-PWR/HS8 cost ratio has almost doubled between 1978 and 1983. The increases represented in Tables ES-5 and ES-6 had been driven by increases in commodities, equipment and manhours, but more recently the increases have been in manhours and indirect costs. Since 1978, craft labor manhours for the 1980's PWR have increased at an average compounded annual rate of 18 percent, while craft manhours for the HS8 have increased at a rate of four percent. In the same period, engineering hours and field supervision manhours have increased at average compounded annual rates of 18 percent and 50 percent respectively for the 1980's PWR, but only six percent and seven percent respectively for the HS8.

The field surveys made concurrently with the Phase V and Phase VI Updates found and verified that both regulatory and construction practices were responsible

for the continuing increase in manhours. Engineering and engineering support services, construction crafts and indirect labor associated with temporary facilities and field supervision were primary contributors to this increase. The surveys also showed a correlation between high manhours and high costs as well as low manhours and low costs. If the median to high cost and manhour experience continues, nuclear power plants will become increasingly less competitive with coal-fired power plants and other alternatives. On the other hand, if the best cost and manhour experience were to prevail in the future, nuclear power plants would most likely be at least as competitive with coal-fired power plants as they were in 1978 when the EEDB Phase I Update showed a PWR/HS8 dollars per kilowatt (electrical) capital cost ratio of 1.3.

NUCLEAR POWER PLANTS FOR THE 1990'S

While Tables ES-3 through ES-6 indicate rapidly rising capital costs for the median experience nuclear power plants, they also show that growth in cost for the best experience plants was close to that of the coal-fired plants. The costs for the 1990's nuclear power plants are representative of the current best industry experience and what may be anticipated for nuclear power plants built in the 1990's, if that experience can be duplicated.

It is expected that the best experience may be duplicated if the necessary regulatory reforms and improved construction practices are promulgated and implemented. Congressional initiatives on regulatory reform, such as the House of Representatives Bill, H.R. 2511, are currently being given serious consideration. The Electric Power Research Institute (EPRI) and others are conducting extensive studies to identify necessary improved construction practices. If the reforms and improvements are to be successful they must reduce or eliminate:

- proliferation of regulations, codes and standards;
- overreaction to these regulations, codes and standards;
- frequent iteration of licensing questions;
- casual commitments and too infrequent one-on-one communications between regulator and regulated;
- extreme precision in analyses, coupled with inflexible design and construction quality assurance procedures;
- excessive safety-related materials/equipment qualification and documentation;
- extensive checking of complex safety-related structural and piping analyses and documentation;
- rework caused by field interferences, constantly changing designs and inadequate engineering-to-construction lead times;

- management preoccupation with I&E (regulatory inspection and enforcement) site visits;

- overlapping or duplication of field supervision functions among utilities and their agents; and

- low worker morale.

Other options for reducing anticipated costs for nuclear power plants of the 1990's include improvement of the best current industry cost and manhour experience, incorporation of advanced reactor designs and reduction of construction schedules below 90 months. These options have the potential to reduce the costs of the nuclear power plants for the 1990's an additional 50 to 100 dollars per kilowatt (electrical) below those given in Table ES-2.

Effective Date 1/1/83

TABLE ES-1

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

NUCLEAR POWER PLANT[a]
COST AND MANHOUR EXPERIENCE

Experience Level	BCC[b] $/kWe	Manhours (MH/kWe)		
		Craft	Engineering	Field Supervision
Best	1399	14	1.8	1.7
Median	1933	25	7.0	9.6
Poorest	2614	31	12.2	14.8

(a) 1100 MWe to 1300 MWe, Single or First-on-Site PWR Units Under Construction, but Over 60 Percent Complete.

(b) Base Construction Cost: Data in January 1, 1983 Constant Dollars without AFUDC, but Including Contingency, Owners Costs, Taxes Other than Payroll, Fees, Permit and License Costs, Switchyard Cost and Generator Step-Up Transformer Cost.

Effective Date 1/1/83

TABLE ES-2

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

SUMMARY OF THE PHASE VI (1983) UPDATE BASE CONSTRUCTION COSTS
(Constant January 1, 1983 Dollars)

Data Model	Nuclear Power Plants						Coal-Fired Power Plants		
	For the 1980's			For the 1990's					
	PWR	BWR	LMFBR	PWR	BWR	LMFBR	HS8	HS5	Twin HS5
MWt	3412	3578	3800	3412	3578	3800	2210	1396	2792 (a)
MWe	1139	1190	1457	1139	1190	1457	791	486	972 (a)
Total Base Construction Costs ($ x 10^6)	2016	2065	2915	1239	1271	1863	663	506	894 (a)
($/kWe)	1770	1735	2001	1088	1068	1279	838	1041	920 (a)

(a) Total capacity and cost for both units of a two-unit station

Effective Date 1/1/83

TABLE ES-3

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

SELECTED COMPARISON OF PHASE I (1978) AND PHASE VI (1983) PLANTS FOR THE 1980'S
BASE CONSTRUCTION COST RESULTS
(Constant January 1, 1983 Dollars)

Data Model	PWR		BWR		LMFBR(a)		HS8(b)		HS5(c)
MWt	3412		3578		3800		2210		1396
MWe	1139		1190		1390, 1457		795, 791		486
EEDB Program Update Phase	I	VI	I	VI	I	VI	I	VI	VI
Total Base Construction Costs ($ x 10^6)	970	2016	997	2065	1469	2915	542	663	506
($/kWe)	852	1770	837	1735	1057	2001	682	838	1041

(a) MWe was 1390 for Phase I Update (1978). Core was changed from homogeneous to heterogeneous type for the Phase V Update (1982).
(b) MWe was 795 for Phase I Update (1978). Scrubber design was updated to 1979 New Source Performance Standards for the Phase III Update (1980).
(c) A comparable coal-fired power generating station technical data model was first developed for the Phase VI Update (1983).

Effective Date 1/1/83

TABLE ES-4

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

SELECTED COMPARISON OF PHASE I (1978) AND PHASE VI (1983) PLANTS FOR THE 1990'S
BASE CONSTRUCTION COST RESULTS
(Constant January 1, 1983 Dollars)

Data Model	PWR		BWR		LMFBR(a)		HS8(b)		HS5(c)
MWt	3412		3578		3800		2210		1396
MWe	1139		1190		1390, 1457		795, 791		486
EEDB Program Update Phase	I	VI	I	VI	I	VI	I	VI	VI
Total Base Construction Costs ($ x 10^6)	970	1239	997	1271	1469	1863	542	663	506
($/kWe)	852	1088	837	1068	1057	1279	682	838	1041

(a) MWe was 1390 for Phase I Update (1978). Core was changed from homogeneous to heterogeneous type for the Phase V Update (1982).

(b) MWe was 795 for Phase I Update (1978). Scrubber design was updated to 1979 New Source Performance Standards for the Phase III Update (1980).

(c) A comparable coal-fired power generating station technical data model was first developed for the Phase VI Update (1983).

Effective Date 1/1/83

TABLE ES-5

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COMPARISON OF PHASE I (1978) AND PHASE VI (1983) UPDATE
1980's PWR, 1990's PWR AND HS8 BASE CONSTRUCTION COST RESULTS
(Constant January 1, 1983 Dollars)

	EEDB Program Update		Average Compound Annual
PWR for the 1980's	Phase I	Phase VI	Increase (%)
Direct Costs	678	996	8
Indirect Costs	286	1020	29
Base Construction Costs	964	2016	16
PWR for the 1990's			
Direct Costs	678	759	2
Indirect Costs	286	480	11
Base Construction Costs	964	1239	5
HS8			
Direct Costs	442	534	4
Indirect Costs	96	129	6
Base Construction Costs	538	663	4

Effective Date 1/1/83

TABLE ES-6

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COMPARISON OF PHASE I (1978), PHASE V (1982) AND PHASE VI (1983) UPDATES
PWR/HS8[a] BASE CONSTRUCTION COST RATIOS

	PWR/HS8 Base Construction Cost[b] Ratio
Phase I Update (1978)	1.2
Phase V Update (1982)	1.6
Phase VI Update (1983)	
PWR for the 1980's	2.1
PWR for the 1990's	1.3

(a) PWR: 1139 MWe
HS8: 791 MWe

(b) Based on Constant Dollars per kWe in the Year of the Estimate

SECTION 1

1.0 OVERVIEW OF THE PHASE VI UPDATE REPORT

1.1 EEDB PROGRAM BACKGROUND

The Energy Economic Data Base (EEDB) provides power plant technical and cost information to the U.S. Department of Energy (DOE). These data support program planning by the Office of the Assistant Secretary for Nuclear Energy. The internally consistent, technical data models for these large power plants (500 MWe to 1500 MWe) provide detailed design data which are the basis for capital cost estimates. The objective of the data base is to develop credible cost estimates that clearly indicate what is included in the costs. This objective is achieved through the inclusion of a high level of detail in the technical data models and clear statements of the ground rules and assumptions on which that detail is based. The data models are detailed to the extent that the user may have confidence in the consistency, balance and comparability of the various alternatives contained in the data base.

The technical data models in the data base have evolved from studies performed by United Engineers & Constructors Inc. over the last 18 years. The data base was assembled in 1978 by formally incorporating and updating the data from the earlier studies. The resultant cost estimates and supporting technical descriptions were published in the EEDB Program - Phase I Update (1978) Report.[1] The EEDB has been updated and new update reports have been issued on an annual basis for the years 1979 through 1982.[2-5] Capital cost estimates based on updated technical data models received the primary emphasis in the update reports and were used to generate the capital associated component of electric generating cost. This component was added to fuel and operating/maintenance costs to predict present and future electricity costs. In this Phase VI Update, the effort was limited to estimating the capital costs for five technical data models without predicting electricity costs. The Sixth (Phase VI) Update incorporated 1983 technical and economic data for a cost and regulation date of January 1, 1983. The data were utilized to estimate power plant costs for the 1980's and to predict nuclear power plant costs for the 1990's. The Phase VI Update of the EEDB Program was authorized under ORNL Sub-contract Number 11X-51944V.

At the conclusion of the Fifth (Phase V) Update, the EEDB contained technical and capital, fuel, and operating and maintenance cost data models for thirteen different types of nuclear power generating stations (NPGS) or fossil power generating stations (FPGS). Each year various technical and cost data models have been selected to be updated. Plant types and cost areas selected have been dependent on available resources and related objectives of the Department of Energy. Data models for plant types and cost areas not included in an update were retained in the EEDB for possible reactivation in a future update. The five updates preceeding this Sixth Update focused on a variety of power plant types at varying levels of effort. An historical record of the plant types included in each of these updates is given in Table 1-1. The Sixth Update has focused on the technical and capital cost data models of five of the nuclear and coal fired power plant data models included in the data base. The data models selected for this update are identified in Table 1-2.

The EEDB Program Reference Book[6] provides the assumptions, reference conditions, and ground rules under which the EEDB technical and cost data models have been developed. The results presented in the EEDB Update Reports are valid only under the described conditions. Therefore, a good understanding of the items included in and excluded from the data models is necessary before the results may be effectively extended to a wider range of conditions and sensitivities. A discussion of what is and is not included in EEDB Program reported costs may be found in the EEDB Program Reference Book.

The Program Reference Book provides important descriptive and tutorial information concerning the structure and use of the EEDB, particularly with respect to the data models' level of detail and the "code-of-accounts" system that provides order and consistency to that detail. It also contains reports of work done to support various aspects of earlier updates, together with significant reference data developed during those updates. The first three sections of the Reference Book describe the EEDB Program, identify the components of the data base and state the ground rules under which costs are developed and updated. Other sections describe the data base components and the technical and cost updating procedures in detail. The user of this Update Report is urged to review the Reference Book before attempting to utilize the data reported herein, in order to derive the maximum benefit from the Update. As a minimum, the user should be familiar with Sections 1 through 3 of the Reference Book.

1.2 THE PHASE VI EEDB PROGRAM OBJECTIVES, GOALS AND SCOPE

The primary goal of the Phase VI Update of the EEDB was to prepare cost estimates that were representative of the current median or average industry experience. A further goal (in support of an assessment of the long term economic potential of the nuclear option) was to begin developing nuclear power plant costs that reflect recent experience with more standardized plants that were built with shorter construction periods. In this regard, the cost impacts of proposed licensing and regulatory reforms were also reviewed.

A further purpose of this Update was to recast the technical data models listed in Table 1-2, to reflect the changing commodity quantities and engineering and construction manhours identified by the Phase VI cost driver investigation field surveys.

In order to obtain the best utilization of resources to meet these objectives, the Phase VI Update effort was dedicated to improving and revising the technical and capital cost data models listed in Table 1-2. The BWR and PWR Updates represent the current U.S. LWR (light water reactor) NPGS experience and practice. The LMFBR NPGS Update is representative of a commercial version of the U.S. LMFBR Program large loop concept. The comparison HS8 and HS5 FPGS Updates are representative of current U.S. coal-fired power plant experience and practice.

Each of the selected technical and capital cost data models were updated at the nine-digit code-of-accounts level of detail. Beginning with the Sixth Update, fuel and operating and maintenance costs will be developed under other DOE programs and will be presented in the report Nuclear Energy Cost Data Base--A Reference Data Base for Nuclear and Coal-Fired Power Plant Power Generation Cost Analysis, DOE/NE-0044. The particular improvements and revisions undertaken in the Phase VI Update are given in the following section.

1.3 SUMMARY OF PHASE VI UPDATE ACTIVITIES

Specifically, the activities pursued to meet the objectives and scope of the Phase VI Update are listed below.

Technical/Cost Changes

1. The EEDB was updated to include January 1, 1983 technical and capital cost data for the technical models given in Table 1-2.

2. Field survey information on power plant engineering and practices relative to craft, engineering and field supervision manhours and representative of current median or average power plant experience was incorporated into the data base.

3. Technical and capital cost data models for the 500 MWe high sulfur coal-fired power plant were expanded from the three-digit code-of-accounts level of detail to the nine-digit level of detail.

4. Structural quantities and costs were reviewed and modified for each of the technical/cost data models, in order to assure the overall technical adequacy of the structural accounts in the data base, and to assure that major building sizes and quantities were reflective of current practice.

5. Electrical system design and related equipment quantities and installation rates were reviewed in detail for each of the technical/cost data models and modified as required to be consistent with current practice.

6. Technical and capital cost models for an HS5 two unit station were developed, using the Sixth Update single unit HS5 technical/ cost data model, shared facilities and learning factors developed during the Sixth Update, as a basis for the second unit technical/cost data models.

7. Indirect costs were examined in detail, particularly with respect to craft, engineering and field supervision man-

hours and were updated to reflect current trends of rising manhours.

8. In addition to evaluating the median nuclear power plant cost experience, the best experience was also evaluated to provide the basis for a potential PWR, BWR and LMFBR for the 1990's based on recent experience with more standardized plants that were built with shorter construction schedules.

9. Individual components of the data base were reviewed for technical accuracy and consistency and were updated as required.

Documentation Changes

1. An EEDB Program Technical Reference Book[7] was prepared, based on consolidation, refinement and updating of the PWR, BWR and HS8 system design descriptions in the Base Data Studies and Reports[8] as updated in the Initial through Sixth Update Reports.

2. System design descriptions were prepared for the LMFBR and HS5, based on the Sixth Update LMFBR technical data model and the Sixth Update expanded HS5 technical data model, for incorporation into the new Technical Reference Book.

The data tables, which make up a large part of this Phase VI Update Report, were updated to the cost and regulation date of January 1, 1983. The data in these tables supersede the corresponding technical and cost information presented in the Phase V Update Report.[2]

1.4 PRESENTATION OF THE EEDB PROGRAM REPORT

For the Sixth Update (1983), the EEDB Program Report is divided into two parts.

This Volume:	Energy Economic Data Base Program Phase VI Update (1983) Report
Companion Volume:	Energy Economic Data Base Program Technical Reference Book[7]

These volumes are supplemented and amplified by the last two report volumes published.

Energy Economic Data Base Program
Phase V Update (1982) Report[2]

Energy Economic Data Base Program
Reference Book[6]

1.4.1 Purpose of the Technical Reference Book

The purpose of the EEDB Technical Reference Book[7] is to provide the current technical design bases for each of the technical data models updated in the Sixth Update (1983). It contains a set of detailed system design descriptions for these technical data models, which are supplemented with engineering drawings. The system design descriptions reflect regulatory and industry practice and experience for nuclear and coal-fired power generating stations that are current for January 1, 1983.

The Table of Contents and the Table and Figure Lists of the Technical Reference Book are included in Table 1-3 at the end of this section for reference. Sections 1 and 2 discuss the technical data models and the assumptions and ground rules on which they are based. Sections 3 through 7 present the system design descriptions and the engineering drawings. It is intended that the Technical Reference Book be periodically updated when required. Significant technical changes will be recorded and described in the Technical Reference Book updates or in those EEDB Update Reports published in the intervening years between Technical Reference Book revisions.

1.4.2 Purpose of the Program Reference Book and Phase V Update Report

The purpose of the Program Reference Book[6] and the Phase V Update (1982) Report[2] is to provide the historical development of the EEDB through the Phase V Update. These documents contain important descriptive and tutorial information concerning the structure and use of the EEDB. They also contain reports of work done to support various aspects of the first five updates,[1-5] together with significant reference data developed during those updates. As a convenience to the user, it is intended that the Program Reference Book be sufficiently stable that revisions are required no more frequently than once every five years.

1.4.3 Purpose of the Phase VI Update Report

The purpose of the Phase VI Update Report is to present the results of the current update, including a detailed description of technical and cost changes made to the Phase V Update. The report includes a detailed description of changes made to the technical data models, and summaries and details of the updated costs based on these changes. Succeeding Update Reports, together with the Program Reference Book, the Technical Reference Book, the Phase V Update Report and the Phase VI Update Report, document the entire data base through the reference date of the last Update Report. It is intended that a new Update Report be published for each update, using a standard format for easy cross referencing.

1.5 ORGANIZATION OF THE PHASE VI UPDATE REPORT

This overview (Section 1) presents a general introduction to the EEDB Phase VI Update. The remaining sections of the Update Report discuss and present the results of the Phase VI Update at the level of detail necessary to convey the findings of the update.

Section 2 of this report presents a summary of the technical and cost update results.

Section 3 of this report discusses the causes and effects of the Phase VI Update cost changes, relative to the results of previous updates and to nuclear/ coal-fired power plant cost trends, particularly in the indirect cost area. The section discusses costs and cost trends for nuclear power plants for both the 1980's and 1990's.

Section 4 presents the details of the Phase VI technical changes for each of the updated models for the 1980's , including key technical parameters and quantities of commodities equipment and labor manhours.

Section 5 presents the Phase VI capital costs for the 1980's for each of the updated data models. The direct cost changes, relative to the technical changes presented in Section 4, and the major indirect cost changes, relative to the available field survey data, are also discussed.

Section 6 presents the technical changes and cost reductions developed during the Sixth Update for the second unit of an HS5 two-unit station and compares the costs with those of the first unit and the total station.

Section 7 presents the Phase VI capital costs for the 1990's for the PWR, BWR and LMFBR. The differences between nuclear power plant costs for the 1980's and 1990's are also discussed, particularly with respect to nuclear/ coal-fired power plant cost trends.

Section 8 contains the complete list of references cited in the Phase VI Update Report.

TABLE 1-1

ENERGY ECONOMIC DATA BASE

TECHNICAL DATA MODEL UPDATE HISTORY
NUCLEAR POWER GENERATING STATIONS

Plant Type	Net Capacity (MWe)	EEDB Data Model[a] Number					
		Initial Update (1978)	2nd Update (1979)	3rd Update (1980)	4th Update (1981)	5th Update (1982)	6th Update (1983)
Boiling Water Reactor Plant (BWR)	1190	A1	A1	A1	A1	A1	A1
High Temperature Gas Cooled Reactor Plant (HTGR)	1330	A2	A2	--	--	--	--
High Temperature Gas Cooled Reactor Plant - Steam Cycle (HTGR-SC)	858	--	--	A2[b]	A2	A2[c]	--
Pressurized Water Reactor Plant (PWR)	1139	A3	A3	A3	A3	A3	A3
Pressurized Heavy Water Reactor Plant (PHWR)	1162	A4	A4	--	--	--	--
Pressurized Heavy Water Reactor Plant (PHWR)	1260	--	--	A4[b]	A4	A4[c]	--
Gas Cooled Fast Reactor Plant (GCFR)[d]	917	B1	B1	--	--	--	--
High Temperature Gas Cooled Reactor Plant - Process Steam (HTGR-PS)	150	--	--	B1[b]	B1	B1	--
Liquid Metal Fast Breeder Reactor Plant (LMFBR)	1390	B2	--	--	--	--	--
Liquid Metal Fast Breeder Reactor Plant (LMFBR)	1457	--	A5[b]	A5	A5	A5	A5

(a) A = Detailed Data Model, Detailed Level Update
B = Summary Data Model, Summary Level Update

(b) Indicates previous model replacement

(c) Summary Level Update of Detailed Data Model

(d) GCFR data model was deleted from the data base in the Third Update (1980)

TABLE 1-1

ENERGY ECONOMIC DATA BASE

TECHNICAL DATA MODEL UPDATE HISTORY
COMPARISON POWER GENERATING STATIONS

Plant Type	Net Capacity (MWe)	EEDB Data Model[a] Number					
		Initial Update (1978)	2nd Update (1979)	3rd Update (1980)	4th Update (1981)	5th Update (1982)	6th Update (1983)
Comparison HIgh Sulfur Coal Plant (HS12)	1232	C1	C1	C1	--	--	--
	1240	--	--	--	C1	--	--
Comparison High Sulfur Coal Plant (HS8)	795	C2	C2	C2	C2	C2	--
Comparison High Sulfur Coal Plant (HS8)	791	--	--	--	--	--	C2[b]
Comparison Low Sulfur Coal Plant (LS12)	1243	C3	C3	C3[e]	--	--	--
	1244	--	--	--	C3	--	--
Comparison Low Sulfur Coal Plant (LS8)	802	C4	C4	C4[e]	--	--	--
	795	--	--	--	C4	--	--
Comparison Coal Gasification Combined Cycle Plant (CGCC)	630	D1	D1	D1	D1	--	--
Comparison Low Sulfur Coal Plant (LS5)	480	--	--	--	D2	--	--
Comparison High Sulfur Coal Plant (HS5)	480	--	--	--	--	D2[b]	--
Comparison High Sulfur Coal Plant (HS5)	486	--	--	--	--	--	C5[b]
Comparison Low Sulfur District Heating Cogeneration Coal Plant (LS5-D/H)	360	--	--	--	D3	--	--
Comparison High Sulfur District Heating Cogeneration Coal Plant (HS5-D/H)	360	--	--	--	--	D3[b]	--

(a) C = Detailed Data Model, Detailed Level Update
D = Summary Data Model, Summary Level Update

(b) Indicates previous model replacement
(e) Added flue gas cleaning to technical model

TABLE 1-2

ENERGY ECONOMIC DATA BASE

NUCLEAR AND COMPARISON POWER GENERATING STATIONS

FOR THE PHASE VI UPDATE (1983)

EEDB Model Number	Plant Type	Net Capacity
A1	Boiling Water Reactor Plant (BWR)	1190 MWe
A3	Pressurized Water Reactor Plant (PWR)	1139 MWe
A5	Liquid Metal Fast Breeder Reactor Plant (LMFBR)	1457 MWe
C2	Comparison High Sulfur Coal Plant (HS8)	791 MWe(a)
C5	Comparison High Sulfur Coal Plant (HS5)	486 MWe(a)

(a) Capacity changed since last update.

TABLE 1-3

EEDB TECHNICAL REFERENCE BOOK

- TABLE OF CONTENTS
- TABLE LIST
- FIGURE LIST

TABLE OF CONTENTS

ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
TECHNICAL REFERENCE BOOK

TABLE OF CONTENTS (cont'd)

ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
TECHNICAL REFERENCE BOOK

LIST OF TABLES

ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
TECHNICAL REFERENCE BOOK

LIST OF FIGURES

ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
TECHNICAL REFERENCE BOOK

SECTION 2

2.0 SUMMARY OF THE PHASE VI TECHNICAL/COST UPDATE RESULTS

2.1 TECHNICAL SUMMARY

The status of the technical data models base parameters for the Phase VI Update is summarized in Table 2-1 for the nuclear power plants and Table 2-2 for the comparison power plants. The summaries present listings of important or key parameters that establish the technical envelope for each NPGS or FPGS selected for updating. The system design descriptions and engineering drawings found in the Technical Reference Book[7] supplement the key parameters.

2.2 CAPITAL COST SUMMARY

Capital costs have been prepared for the EEDB as "overnight" base construction costs, which are the sum of the direct and indirect costs. Direct costs comprise equipment and commodity costs and the costs of necessary site material and labor for installation of the equipment and commodities. Indirect costs include the costs of construction services, engineering, engineering support, construction management, field supervision, quality assurance, insurance and taxes, and other expenses such as payroll, overhead, and fees. EEDB base construction costs include only those cost elements described in the EEDB Program Reference Book.[6] They specifically exclude owner's costs, contingencies, escalation and allowance for funds used during construction. Direct, indirect and base construction costs are summarized in Table 2-3 for the updated power plant data models.

Tables 2-4 and 2-5 also summarize the same data for the updated technical/cost data models, except that the capital costs have been normalized to the identical electrical or thermal capacities, respectively. The normalization process is discussed in Section 6 of the Program Reference Book. The net electrical capacity chosen for this process is that of the EEDB PWR, so that capital costs of the other technical data models can be compared to this most frequently chosen industry cost base. The nominal thermal capacity chosen for the normalization process is the maximum licensable nuclear power plant thermal rating of 3800 MWt, so that costs may also be compared on the basis of maximum licensable capacity.

Costs given in this section are representative of power plants for the 1980's. Comparable data are given for nuclear power plants for the 1990's in Section 7. All costs in this update report are presented as January 1, 1983 constant dollars.

TABLE 2-1

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
NUCLEAR POWER GENERATING STATIONS
TECHNICAL DATA MODELS BASE PARAMETER SUMMARY

	PWR	BWR	LMFBR
GENERAL			
1. Site	Middletown, USA	Middletown, USA	Middletown, USA
2. Operation	Base Load	Base Load	Base Load
3. Technical Data Model Reference Date*	January 1, 1983*	January 1, 1983*	January 1, 1983*
4. Plant Life (years)	30	30	30
5. Number of Units	Single	Single	Single
6. Thermal Power (MWt)	3,412	3,578	3,800
7. Net Plant Heat Rate (Btu/kWh)	10,224	10,261	8,902
8. Net Plant Efficiency (%)	33.38	33.26	38.34
9. Net Power to GSU(a) (MWe)	1139	1190	1457
10. Water Table (Feet above mean river level)	10	10	10
11. 100 Year Maximum Water Level (Feet above mean river level)	8	8	8
12. External Missiles	Tornadoes Only	Tornadoes Only	Tornadoes Only
LICENSING			
13. Codes & Standards Reference Date	January 1, 1983*	January 1, 1983*	January 1, 1983*
CIVIL/STRUCTURAL			
14. Containment			
a. Type	Reinforced Concrete with Steel Plate Liner	Free Standing Steel Containment with Reinforced Concrete Shield Building	Reinforced Concrete with Steel Plate Liner
b. Overall Height (ft)	219	187 (Steel Vessel) 197 (Shield Building)	276

(a) Generator Step-up Transformer
* Designates changes from the Phase V Update (1982) - Refer to Reference 2

TABLE 2-1

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
NUCLEAR POWER GENERATING STATIONS
TECHNICAL DATA MODELS BASE PARAMETER SUMMARY

	PWR	BWR	LMFBR
CIVIL/STRUCTURAL (cont'd)			
c. Inside Diameter (ft)	140	120 (Steel Vessel) 130 (Shield Building)	187
d. Free Volume (10^6 cu ft)	2.8	2.4 (Steel Vessel)	6.0
e. Design Pressure (psig)	52	25 (Dry Well) 15 (Containment)	5
15. Turbine Building	Enclosed	Enclosed	Enclosed
16. Turbine Pedestal	High Tuned	High Tuned	High Tuned
17. Fuel Storage (Number of Cores)	4/3	5/4	4/3
18. Flooding Provisions	No Special Provisions	No Special Provisions	No Special Provisions
19. Seismic SSE/OBE (g)	0.25/0.125	0.25/0.125	0.25/0.125
20. Foundations (Type)			
a. Seismic Category I	Mat	Mat	Mat
b. Non-Seismic Category I	Spread Footings	Spread Footings	Spread Footings
21. Grade Elevation (Feet above mean river level)	18	18	18
MECHANICAL			
22. Reactor			
a. Type	Cylindrical Carbon Steel Pressure Vessel with Stainless Steel Cladding, Hemispherical Bottom Head and Removable Hemispherical Upper Head	Cylindrical Carbon Steel Pressure Vessel with Stainless Steel Cladding, Hemispherical Bottom Head and Removable Hemispherical Upper Head	Cylindrical Stainless Steel Vessel with Torispherical Bottom Head and Flat Cover Structure with Rotating Plugs
b. Vessel Inside Diameter/Height (in/in)	173/516	238/DNA(b)	446/544

(b) DNA = Data Not Available

TABLE 2-1

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
NUCLEAR POWER GENERATING STATIONS
TECHNICAL DATA MODELS BASE PARAMETER SUMMARY

	PWR	BWR	LMFBR
MECHANICAL (Cont'd)			
c. Number Fuel Assemblies*	193*	748*	438 (Fuel) 308 (Blanket)*
d. Initial Core	UO_2	UO_2	$UO_2 + PuO_2$
e. Enrichment (%)	3	3	0.88
f. Refueling Method	- Inclined Tube Fuel* Transfer System* Between Fuel Pool* and Reactor Vessel* - Rail Mounted Refuel-* ing Platform with* Telescoping Grapple* over Fuel Pool*	- Inclined Tube Fuel Transfer System Between Fuel Pool and Reactor Vessel - Rail Mounted Refuel- ing Platform with Telescoping Grapple over Fuel Pool	- Rotating Plugs, In-Vessel Refueling and Inclined Tube* Fuel Transfer System* - Rail Mounted Trans-* lating "A" - Frame
23. Primary Fluid Type/Wt (10^5 lbs)	Light Water/5.70	Light Water/1.60	Liquid Sodium: Primary Loops/43; Intermediate Loops/31
24. Moderator	Light Water	Light Water	Not Applicable
25. Reactor Coolant Conditions at Reactor Outlet			
a. Temperature (°F)	618	544 (Steam)	950
b. Pressure (psia)	2,250	1,040 (Steam)	Atmospheric
c. Flow (10^6 lb/h)	140.3	15.4 (Steam) 31.7 (Water Recirc.)	143.2
26. Reactor Coolant/Recirculation Loops			
a. Number of Loops/Number of Pumps per Loop	Four/one	Two (Recirculation Only)/One	Four (Primary)/One Four (Intermediate)/ One
b. Drive Type/HP	Electric Motor/7000 (hot)* Electric Motor/9000* (cold)*	Electric Motor/7630	Variable Speed Electric Motor (Primary and Intermediate)/ 9,000 (Primary) 7,000 (Intermediate)

* Designates changes from the Phase V Update (1982) - Refer to Reference 2

TABLE 2-1

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
NUCLEAR POWER GENERATING STATIONS
TECHNICAL DATA MODELS BASE PARAMETER SUMMARY

	PWR	BWR	LMFBR
MECHANICAL (cont'd)			
27. Steam Generators		None Required. (In* the BWR, steam is* produced in the* reactor vessel. After* passing through the* steam dryer in the* reactor vessel dome,* steam is collected and* piped directly to the* turbine generator* inlet and the inlet of* the reheater portion* of the moisture* separator/reheater.)*	
a. Number per Coolant Loop	1		2
b. Type	Vertical U-Tube with Integral Steam Drums		Single Wall, Straight Tube, Once-Through, Combined Evaporator/ Superheater
c. Classification (Section III, ASME B&PVC)	Tube Side - Class 1 Shell Side - Class 2		None (Steam generator* is external to the* reactor containment* building and separated* from the safety class* portion of the inter-* mediate sodium loop* by isolation valves)*
d. Heat Transfer Surface (SF)	181,120		378,872
e. Steam Flow (10^6 lb/h)	15.1		14.4
f. Outlet Steam Pressure (psia)	1,000		2,365*
28. Turbine-Generator			
a. Configuration	Tandem-Compound, 6-Flow	Tandem-Compound, 6-Flow	Tandem-Compound, 6-Flow
b. Speed (r/min)	1,800	1,800	1,800
c. Last Stage Blade Length (ins)	43	43	43
29. Main Steam Conditions at High Pressure Turbine Inlet			
a. Pressure (psia)	975	960	2,200
b. Temperature (^oF)	544	544	850
c. Throttle Flow (10^6 lb/hr)	13.7	13.9	13.1
30. Gross Turbine-Generator Output at 2.5 Inches HgA (Guarantee) (MWe)	1,192	1,235	1.547

* Designates changes from the Phase V Update (1982) - Refer to Reference 2

TABLE 2-1

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
NUCLEAR POWER GENERATING STATIONS
TECHNICAL DATA MODELS BASE PARAMETER SUMMARY

	PWR	BWR	LMFBR
MECHANICAL (Cont'd)			
31. Condensers			
a. Shell/Divisions per Shell	3/1	3/1	3/1
b. Arrangement	Transverse	Transverse	Transverse
c. Number of Passes	Two	Two	Two
d. Water Box	Split	Split	Split
e. Pressure	Single	Single	Single
f. Total Heat Transfer Surface (SF)	1,212,000	1,279,581	1,252,473
32. Cooling Tower			
a. Type	Mechanical Wet Evaporative	Mechanical Wet Evaporative	Mechanical Wet Evaporative
b. Number/Total Flow - Normal (gpm)	3/712,530	3/752,118	3/742,599
33. Cooling Tower Conditions			
a. Approach (^{o}F)	14	14	14
b. Range (^{o}F)	22	22	22
c. Wet Bulb (^{o}F)	74	74	74
34. Ultimate Heat Sink	2-100% Mechanical Wet Evaporative Cooling Towers	2-100% Mechanical Wet Evaporative Cooling Towers	2-100% Sodium to Air Heat Exchangers with Electric Motor Driven Fans
35. Feedwater Pumps			
a. Main (Number/Drive)	2/Turbine	2/Turbine	2/Turbine
b. Other (Number/Service/Drive)	1/Emergency/Turbine 1/Emergency/Motor 1/Start-up/Motor	1/Start-up/Motor	1/Start-up/Motor

TABLE 2-1

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
NUCLEAR POWER GENERATING STATIONS
TECHNICAL DATA MODELS BASE PARAMETER SUMMARY

	PWR	BWR	LMFBR
MECHANICAL (Cont'd)			
36. Feedwater Heaters			
a. Open Stages (Number)	None	None	One
b. High Pressure Closed Stages (Number/Number Trains)	1/2	1/2	1/3
c. Low Pressure Closed Stages (Number/Number Trains)	4/3, 1/2	4/3, 1/2	4/3
37. Stages of Reheat (Number/Type)	One/Steam	One/Steam	Two/Steam
ELECTRICAL			
38. Connection to Off-site Power (Number/kV)	2*/500, 2*/230	2*/500, 2*/230	2*/500, 2*/230
39. Generator			
a. Rating (MVA)	1,350	1,400	1,750*
b. Voltage (kV)	25	25	25
c. Power Factor	0.9	0.9	0.9
d. H_2 Pressure (psig)	75	75	75
40. Generator Disconnect			
a. Type	Load Break Switch	Load Break Switch	Load Break Switch
b. Rating (kV)	36	36	36
41. Auxiliary Power System			
a. Medium Voltage System A (kV)	13.8	13.8	13.8
b. Medium Voltage System B (kV)	4.16	4.16	4.16
c. Low Voltage System (V)	480	480	480
d. Direct Current Systems (V)	250/125	250/125	250/125

* Designates changes from the Phase V Update (1982) - Refer to Reference 2

TABLE 2-1

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
NUCLEAR POWER GENERATING STATIONS
TECHNICAL DATA MODELS BASE PARAMETER SUMMARY

	PWR	BWR	LMFBR
ELECTRICAL (Cont'd)			
42. Unit Auxiliary Transformer Nameplate Rating[c] (MVA)	90	80	131
43. Reserve Auxiliary Transformer Nameplate Rating[c] (MVA)	90	80	73
44. Diesel-Generator Unit			
a. Type/Number	Medium Speed/2	Medium Speed/3	Medium Speed/2
b. Voltage (kV)	4.16	4.16	4.16
c. Rating (kW/PF)	6083/0.8	5500/0.8	6000/0.8
45. Control Room Wiring	Wired Directly to Panels in Control Room	Wired Directly to Panels in Control Room	Wired Directly to Panels in Control Room
46. Multiplexing of Balance-of-Plant Cables	None	None	None
47. Instrumentation	Independent Sensors for Computer Input	Independent Sensors for Computer Input	Independent Sensors for Computer Input

(c) Total of all transformers at top class of cooling rating

TABLE 2-2

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
COMPARISON POWER GENERATING STATIONS
TECHNICAL DATA MODELS BASE PARAMETER SUMMARY

		HS8	HS5
GENERAL			
1.	Site	Middletown, USA	Middletown, USA
2.	Operation	Base Load	Base Load
3.	Technical Data Model Reference Date*	January 1, 1983*	January 1, 1983*
4.	Plant Life (years)	30	30
5.	Number of Units	Single	Single
6.	Thermal Power (MWt)	2210	1396*
7.	Net Plant Heat Rate (Btu/kWh)	9536*	9804*
8.	Net Plant Efficiency (%)	35.79*	34.81*
9.	Net Power to GSU(a) (MWe)	791*	486*
10.	Water Table (Feet above mean river level)	10	10
11.	100 Year Maximum Water Level (Feet above mean river level)	8	8
CIVIL/STRUCTURAL			
12.	Boiler House	Enclosed	Enclosed
13.	Turbine Building	Enclosed	Enclosed
14.	Turbine Pedestal	High Tuned	High Tuned
15.	Flooding Provisions	No Special Provisions	No Special Provisions
16.	Seismic	Uniform Building Code Zone 1	Uniform Building Code Zone 1
17.	Foundations	Spread Footings on Rock	Spread Footings on Rock

(a) Generator Step-Up Transformer
* Designates changes from the Phase V Update (1982) - Refer to Reference 2

TABLE 2-2

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
COMPARISON POWER GENERATING STATIONS
TECHNICAL DATA MODELS BASE PARAMETER SUMMARY

	HS8	HS5
MECHANICAL		
18. Grade Elevation (Feet above mean river level)	18	18
19. Steam Generator Type	Pulverized Coal Balanced Draft Furnace	Pulverized Coal Balanced Draft Furnace
20. Steam Generator Outlet Conditions		
a. Maximum Continuous Rating (10^6 lb/h)	6.5	3.8*
b. Normal Superheater Outlet (10^6 lb per h/psig/°F)	5.7*/2640/1010	3.5*/2640/1010
c. Normal Reheater Outlet (10^6 lb per h/psig/°F)	5.2/DNA(b)/1000	3.2*/DNA(b)/1005
21. Forced Draft Fan		
a. Number	2	2
b. Drive	Motor	Motor
c. Capacity (acfm)	680,000	300,000*
22. Induced Draft Fan		
a. Number	4	2
b. Drive	Motor	Motor
c. Capacity (acfm)	815,000*	1,080,000*
23. Fuel Type	Eastern Coal	Eastern Coal
a. Moisture (% by wt)	11.3	11.3
b. Ultimate Analysis (% by dry wt)	Carbon 69.34 Chlorine 0.04 Hydrogen 4.90 Sulfur 3.61 Nitrogen 0.86 Oxygen 9.65	Carbon 69.34 Chlorine 0.04 Hydrogen 4.90 Sulfur 3.61 Nitrogen 0.86 Oxygen 9.65
c. Calorific Value (Btu/lb)	As Received 11,026 Dry 12,432	As Received 11,026 Dry 12,432

(b) DNA = Data Not Available
* Designates changes from the Phase V Update (1982) Refer to Reference 2

TABLE 2-2

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
COMPARISON POWER GENERATING STATIONS
TECHNICAL DATA MODELS BASE PARAMETER SUMMARY

		HS8	HS5
MECHANICAL (Cont'd)			
	d. Ash (% by dry wt)	11.6	11.6
24.	Coal Delivery	100 Car Unit Train at 5 hour Maximum Turnaround	100 Car Unit Train at 5 hour Maximum Turnaround
25.	Coal Storage	60 Days at Full Load, 8 hours in Silos	60 Days at Full Load, 8 hours in Silos
26.	Coal Firing Rate (tons/day - turbine guarantee)	8,208	5,184*
27.	Coal Handling System	Rotary Car Dumper, Coal* Breaker, Stacker/Reclaimer* Transfer Tower, Stacker/* Reclaimer, Crusher,* Boiler House Transfer Tower,* Trippers*	Rotary Car Dumper, Coal* Breaker, Stacker/Reclaimer* Transfer Tower, Staker/* Reclaimer, Crusher,* Boiler House Transfer Tower,* Trippers*
28.	Number of Pulverizers/ Spares*	7/1*	5/1*
29.	Stack Height (ft)	750	750
30.	SO_2 Scrubber		
	a. Type	Lime (Wet) with Electrostatic Precipitator	Lime (Wet) with Electrostatic Precipitator
	b. Number of Modules/ Number of Spares	5/1	4/1
31.	Sludge Fixation	On-Site	On-Site
32.	Waste Disposal	Trucked Off-site	Trucked Off-Site
33.	Turbine-Generator	Subcritical	Subcritical
	a. Configuration	Tandem-Compound, 6-Flow	Tandem-Compound, 4-Flow
	b. Speed (r/min)	3600	3600
	c. Last Stage Blade Length (ins)	30*	30*

* Designates changes from the Phase V Update (1982) - Refer to Reference 2

TABLE 2-2

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
COMPARISON POWER GENERATING STATIONS
TECHNICAL DATA MODELS BASE PARAMETER SUMMARY

	HS8	HS5
MECHANICAL (Cont'd)		
34. Main Steam Conditions at High Pressure Turbine Inlet (Guarantee)*		
a. Pressure, psia	2415	2415
b. Temperature - Main Steam/Reheat (°F)	1000/1000	1000/1000
c. Throttle Flow (10^6 lb/hr)	5.8	3.5*
35. Gross Turbine-Generator Ouptut at 2.5 Inches HgA (Guarantee) (MWe)*	850*	523*
36. Condensers		
a. Shell/Divisions per Shell	3/1*	1/1
b. Arrangement	Transverse*	Longitudinal
c. Number of Passes	One	One
d. Water Box	Split	Split
e. Pressure	Single*	Single*
f. Total Heat Transfer Surface (SF)	498,000	347,000*
37. Cooling Tower		
a. Type	Round Mechanical Wet Evaporative	Round Mechanical Wet Evaporative
b. Number/Total Flow - Normal (gpm)	2/173,535	1/257,000*
38. Cooling Tower Conditions		
a. Approach (°F)	14	14
b. Range (°F)	24	24*
c. Wet Bulb (°F)	74	74

* Designates changes from the Phase V Update (1982) - Refer to Reference 2

TABLE 2-2

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
COMPARISON POWER GENERATING STATIONS
TECHNICAL DATA MODELS BASE PARAMETER SUMMARY

	HS8	HS5
MECHANICAL (Cont'd)		
39. Feedwater Pumps		
a. Main (Number/Drive)	2/Turbine	2/Turbine
b. Other (Number/Service/Drive)	2/Booster/Motor	2/Booster/Motor
40. Feedwater Heaters		
a. Open Stages (Number)	One	One
b. High Pressure Closed Stages (Number/Number Trains)	2/2	2/1
c. Low Pressure Closed Stages (Number/Number Trains)	1/3* 3/2*	1/2* 3/1*
41. Stages of Reheat (Number/Type)	One/Boiler	One/Boiler
ELECTRICAL		
42. Connection to Offsite Power (Number/kV)	2*/500, 2*/230	2*/230, 2*/115
43. Generator		
a. Rating (MVA)	1050	632*
b. Voltage (kV)	25	25
c. Power Factor	0.9	0.9
d. H_2 Pressure (psig)	75	75
44. Generator Disconnect	Bolted Links*	Bolted Links*
45. Auxiliary Power System		
a. Medium Voltage System A (kV)	13.8	None
b. Medium Voltage System B (kV)	4.16	4.16
c. Low Voltage System (V)	480	480

* Designates changes from the Phase V Update (1982) - Refer to Reference 2

TABLE 2-2

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
COMPARISON POWER GENERATING STATIONS
TECHNICAL DATA MODELS BASE PARAMETER SUMMARY

	HS8	HS5
ELECTRICAL (Cont'd)		
d. Direct Current Systems(v)*	250/125*	250/125*
46. Unit Auxiliary Transformer Nameplate Rating(c) (MVA)	95	44
47. Reserve Auxiliary Transformer Nameplate Rating(c) (MVA)	48	22
48. Diesel-Generator Unit		
a. Type/Number	High Speed/2	High Speed/2
b. Voltage (V)	480	480
c. Rating (kW/PF)	400/0.8	400/0.8
49. Control Room Wiring	Wired Directly to Panels in Control Room	Wired Directly to Panels in Control Room
50. Multiplexing of Cables	None	None
51. Instrumentation	Independent Sensors for Computer Input	Independent Sensors for Computer Input

(c) Total of all transformers at top class of cooling rating

TABLE 2-3

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
CAPITAL COST UPDATE SUMMARY
($1983 x 10^6)[a]

Model	Nuclear Plant Data Models			Comparison Plant Data Models	
	PWR	BWR	LMFBR[b]	HS8	HS5
MWt	3412	3578	3800	2210	1396
MWe	1139	1190	1457	791	486
Direct Cost	996	1024	1551	534	406
Indirect Cost	1020	1041	1364	129	100
Base Construction Cost	2016	2065	2915	663	506
$/kWe	1770	1735	2001	838	1041

(a) Data in January 1, 1983 Constant Dollars
(b) Reported costs do not include cost of the initial inventory of sodium

TABLE 2-4

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
NORMALIZED[a] CAPITAL COST UPDATE SUMMARY
($1983 x 10^6)[b]

Model	Nuclear Plant Data Models			Comparison Plant Data Model(c)
	PWR	BWR	LMFBR(d)	HS8
MWt	3412	3425	2971	3182
MWe	1139	1139	1139	1139
Direct Cost	996	1006	1382	725
Indirect Cost	1020	1023	1215	175
Base Construction Cost	2016	2029	2597	900
$/kWe	1770	1781	2280	790
$/kWe / PWR $/kWe	1.00	1.01	1.29	0.45

(a) Normalized to a plant size providing 1139 MWe (net)
(b) Data in January 1, 1983 Constant Dollars
(c) Normalization not Applicable to HS5
(d) Reported costs do not include cost of the initial inventory of sodium

TABLE 2-5

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
NORMALIZED[a] CAPITAL COST UPDATE SUMMARY
($1983 x 10^6)[b]

	Nuclear Plant Data Models			Comparison Plant Data Models[c]
Model	PWR	BWR	LMFBR(d)	HS8
MWt	3800	3800	3800	3800
MWe	1269	1264	1457	1360
Direct Cost	1041	1050	1551	842
Indirect Cost	1066	1067	1364	203
Base Construction Cost	2107	2117	2915	1045
$/kWe	1660	1675	2001	768
$/kWe / PWR $/kWe	1.00	1.01	1.21	0.46

(a) Normalized to a plant size of 3800 MWt or its equivalent
(b) Data in January 1, 1983 Constant Dollars
(c) Normalization Not Applicable to HS5
(d) Reported costs do not include cost of the initial inventory of sodium

SECTION 3

3.0 CAUSES AND EFFECTS OF THE PHASE VI UPDATE CHANGES

3.1 INTRODUCTION

The Phase VI Update of the Energy Economic Data Base has developed base construction costs for nuclear and coal-fired power plants, in terms of January 1, 1983 constant dollars. The EEDB Program provides this updated cost information on a periodic basis for use in other estimates of generating costs. The updates are also used to indicate trends from which general conclusions may be made about future power costs. The Phase V (1982) Update was the most comprehensive update since the Phase I (1978) Update. The Phase VI Update has extended the work of the Phase V Update and has verified that the cost trends identified in the Phase V Update have continued. Consequently, these three updates are benchmarks through which significant technical and cost drivers may be identified over the last six years.

3.2 NUCLEAR/COAL POWER PLANT COST TRENDS DURING THE EEDB PROGRAM

3.2.1 Perception of Nuclear/Coal Cost Trends

In 1978, the year of the Phase I Update, the estimated cost for electricity was estimated to be significantly less from a nuclear power plant than from a coal-fired power plant of comparable capacity. However, when the Phase V Update was issued in 1982, the estimated cost of electricity from nuclear and coal-fired power plants were almost the same. A significant factor contributing to the decrease in economic advantage for nuclear power plants was their large capital cost increase over this period compared with the much smaller capital cost increase for coal-fired power plants. As was discussed in the Phase V Update Report, the rapid rise in nuclear power plant capital costs was due primarily to large increases in the quantities of craft, engineering and field service manhours and to a lesser extent to increases in the quantities of commodities and equipment. This and other factors, such as mounting interest on funds used during construction, the ability to generate funds needed for construction, licensing delays, and long construction times have had profound effects on a utility's decision regarding the type of generating station to be constructed.

The Phase VI Update focused on the principal nuclear power plant cost drivers when the overnight base construction costs of nuclear and comparison power plants were estimated for 1983. The base construction cost for the EEDB PWR, representing median LWR industry cost experience, was estimated to be $1,770/kWe in the Phase VI Update. The base construction cost for the EEDB HS8 was estimated to be $838/kWe in the Phase VI Update. A field survey of PWR nuclear power plants approaching completion conducted during the Phase VI Update indicates that the estimated base construction costs plus owner's costs and contingency in 1983 constant dollars without AFUDC, ranged from $1,400/kWe to $2,600/kWe in 1983. The relationship between nuclear power industry reported costs in January, 1983 dollars and the EEDB estimated nuclear and coal-fired power plant capital costs are as follows:

EEDB Estimated Costs	$/kWe (1983) PWR	EEDB HS8	PWR/ HS8
Phase VI Update (1983)	1770	838	2.11
Phase I Update (1978)	852	682	1.25
Phase VI Update Adjusted[(a)](1983)	2049	975	2.10
Phase I Update Adjusted[(a)](1978)	1021	782	1.31

(a) Includes Owner's Cost and Contingency

Nuclear Industry Reported Costs	$/kWe (1983) PWR[(a)]	EEDB HS8[(b)]	PWR/ HS8
Lowest	1399	975	1.43
Median	1933	975	1.98
Highest	2614	975	2.68

(a) Includes Owner's Cost and Contingency
(b) Phase VI Update Adjusted (1983) Cost from Table Above

3.2.2 Nuclear Power Plant Cost Drivers

One of the initial objectives of the Phase VI Update was to maintain the LWR technical/cost data models at a level where they were representative of major cost trends in the nuclear power industry. As indicated in the comparison given in Section 3.2.1, this objective has been accomplished, because the PWR Phase VI Update Adjusted Costs falls near the industry reported median. However, in the earlier updates, the PWR data models were more representative of the lowest cost experience when the range of nuclear power plant costs was not as wide as in 1983.

The Phase V Update and associated Nuclear Plant Construction Field Survey identified the fact that nuclear power plant costs were rising at twice the rate of inflation and were being driven by rapidly increasing quantities of commodities and manhours. This is discussed in the Executive Summary of the Phase V Update report, related excerpts of which are included for reference in Appendix C. These increases were identified as being caused by a variety of conditions. Among these conditions were proliferation of regulations, codes and standards; owner/designer overreaction to these regulations, codes and standards; rework caused by field interferences, constantly changing designs and inadequate engineering-to-construction lead times; extreme precision in analyses, coupled with inflexible design and construction quality assurance procedures; management preoccupation with I&E (regulatory inspection and enforcement) site visits; and low worker morale, caused by all of the above.

The Phase VI Update and field survey supported comparison studies conducted during the Phase VI Update have found that these trends continue and that craft, engineering and field supervision manhours have become the predominant cost drivers. Details of the Phase VI technical data model and cost data model updates are discussed in Sections 4 and 5 respectively.

3.2.3 Base Construction Costs

Base construction costs are controlled by the following five factors:

- quantities of commodities and equipment;
- quantities of unit installation manhours for commodities and equipment;
- quantities of engineering and construction service manhours;
- unit costs for commodities and equipment; and
- craft labor rates and service manhour rates.

Total installation manhours are determined as the product of the first two items. Base construction costs are driven by variations in the first three items; the quantities of commodities, equipment and manhours. The last two items are mainly affected by inflation and amplify the cost levels determined by the first three items.

Figure 3.1 shows PWR and HS8 base construction cost trends from the Phase I Update (1978) through the Phase VI Update (1983). The costs are normalized on the basis of dollars per kilowatt and are all in terms of 1983 constant dollars. The cost bars are divided into the two areas: "labor" (craft, engineering and field supervision) costs and "factory equipment plus site material" (commodities/equipment) costs.

The figure clearly shows the following:

- Commodities/equipment costs have grown by nearly 35 and 25 percent above inflation for the PWR and the HS8 respectively since 1978.
- The cost relationship between commodities/equipment for the PWR and HS8 has not changed significantly since 1978.
- Total labor costs (craft, engineering and field supervision) have increased by about 200 percent above inflation for the PWR between 1978 and 1983.
- Total labor costs have only increased by about 25 percent above inflation for the HS8 between 1978 and 1982 and have kept pace with inflation between 1982 and 1983.

Labor costs are the predominant cost drivers that are causing nuclear power plants to become less competitive with coal-fired power plants. Since labor rates for the three years considered have been adjusted for inflation, the figure shows that there has been a real labor cost increase. The field survey results indicate that this increase has been caused by rising quantities of commmodities and equipment being installed and from decreased productivity. It is believed that the productivity decline has been caused by rework (design changes, interferences, inadequate lead-times) and delays (extended schedules, quality assurance, inspections). A more detailed discussion of these causes and effects is given in Appendix C. However, it must be emphasized, as discussed in the next two paragraphs, that increases in indirect costs rather than in craft labor are the most significant part of the increase. The indirect costs include the cost of craft labor associated with construction services, engineering and engineering support and field non-manual labor.

Figure 3.2 shows the relationship and content of the commodity/equipment part of the cost bar in Figure 3.1. These equipment/material costs are discussed under the following three broad categories:

1. Items whose costs are primarily associated with manufacturers' prices: NF (nuclear or fossil steam supply system), SR (SO_2 removal system), T-G (turbine-generator unit), and M (mechanical equipment such as pumps, heat exchangers, tanks, insulation, and equipment for fire control, HVAC and water purification).

   These costs did not change significantly between 1982 and 1983 for either the PWR or the HS8. Between 1978 and 1982, the steam supply system and the turbine-generator costs increased faster than the average inflation rate; the SO_2 removal system increased greatly because of design changes required to meet the 1977 (became effective in 1979) New Source Performance Standards.

2. Items whose costs are primarily associated with quantity: P (piping including valves and supports), E (electrical equipment, wiring and raceways, instruments, and communication equipment), SS (structural support, which includes concrete with its formwork, reinforcing and embedded steel), and S (other structural including structural steel, interior and exterior walls, paint, and excavation).

   Between 1982 and 1983, these costs changed by a minimal to a moderate amount for the PWR. Except for a minimal adjusted decrease in the electrical account, these costs did not change significantly for the HS8. Between 1978 and 1982, these costs increased significantly faster than the average inflation rate for the PWR and at about the same rate as the inflation rate for the HS8. The reasons behind the nuclear power plant increases are discussed in Appendix C.

3. Item CS, whose costs for construction services appears in the indirect costs and covers temporary buildings, temporary facilities, and construction tools and equipment.

   For the PWR, this account grew by 50 percent more than the inflation rate between 1982 and 1983 and by 120 percent over inflation from 1978 to 1983. These increases reflect lengthened construction schedules, an increase in buildings for field supervision, the increase in craft labor, and the need for more temporary facilities. For the HS8, this account kept pace with inflation from 1982 to 1983 but showed an increase from 1978 to 1983 that was slightly greater than inflation.

Figure 3.3 shows the relationship and breakdown of the labor part of the cost bars in Figure 3.1. This figure emphasizes the extreme increase of labor costs over the inflation rate for the PWR compared to the relatively small increase for the HS8. The increases shown for the HS8 between 1978 and 1982 are largely related to the increase in capacity, complexity and sophistication of the flue gas desulfurization systems. The following discussion pertains only to the PWR:

1. SC - The cost for structural craft labor increased by about 75 percent between 1978 and 1982. This change results from the increase in quantities and the decrease in productivity discussed above. Between 1982 and 1983, the change was insignificant.

2. MC - The cost for mechanical craft labor increased by almost 50 percent between 1978 and 1982, because of quantity increases and productivity decreases. A further increase of about 50 percent between 1982 and 1983 had a similar cause. Mechanical craft labor is primarily utilized for the installation of piping, as well as the reactor and other equipment.

3. EC - The cost for electrical and instrumentation craft labor increased by more than 150 percent between 1978 and 1982. The 12 percent decrease between 1982 and 1983 was caused by underestimating labor productivity in 1982, relative to the 1982 and 1983 field surveys.

4. CS - The labor cost to install the temporary buildings and facilities plus the other "craft labor" under indirect costs increased by about 100 percent between 1978 and 1982 and by about 100 percent more between 1982 and 1983. These increases were partly caused by the conditions identified in item (3) of the discussion on Figure 3.2 and were partly caused by labor not previously identified in the field surveys.

5. E - The cost for engineering, which includes payroll expenses, engineering support costs and other related costs, increased by more than 100 percent from 1978 to 1982 and by an additional 20 percent from 1982 to 1983. The reasons for these increases are discussed in detail in Appendix C.

6. FS - The cost for field supervision, which includes payroll expenses and other related costs, increased by more than 250 percent from 1978 to 1982 and by an additional 170 percent from 1982 to 1983. The dramatic increase in this account results from the greater number of craft laborers being supervised and even more from the uncertainties caused by regulation and the inefficiences of current practice, as discussed in Appendix C.

   The field supervision (FS) plus engineering (E) costs now equal almost half of the total labor dollars required to build a PWR. If the remaining indirect costs associated with labor (CS, O, and I&T) are added to engineering and field supervision costs, the total 1983 labor related indirect costs equal 220 percent of the craft labor costs. These indirect-costs/craft-labor-cost percentages were 144 percent 1982 and 112 percent in 1978.

7. O - The other labor cost covers field office expenses and plant startup and testing. Although this account has been growing greatly in terms of percentage from 1978 to 1983, the account still represents a small part of the labor cost because of the increases in field supervision and engineering.

8. I&T - Insurance and taxes is a direct function of the cost for craft plus construction services labor. However, between 1978 and 1982, the average percentage of wages required for insurance and taxes increased so that this account increased more rapidly than the direct labor account increased.

In summary, the indirect labor costs have increased much more rapidly for the PWR than for the HS8. Consequently, the total indirect costs are 102 percent of the direct costs for the PWR in 1983, but only 24 percent of the direct costs for the HS8.

The large rise in PWR labor costs may be attributed to continuation of the trends discussed in the previous section and in Appendix C and verified by industry experience. This experience data base includes low cost as well as high cost unit experience. The low cost experience appears to coincide with low craft, engineering and field supervision manhours. This would seem reasonable from an examination of Figures 3.2 and 3.3. Comparison of the costs for the PWR and HS8 in Figure 3.2 indicates that PWR commodities/equip-

ment costs will probably not be significantly reduced in areas other than construction services. Comparison of the costs for the PWR and HS8 in Figure 3.3 indicates that there are many potential areas for reduction of PWR labor costs in the form of reductions in manhours. Since the manhours are being driven by the conditions discussed in Section 3.2.2, implementation of the regulatory reforms initiated by DOE and the supporting industry actions recommended in the Phase V Update (see Appendix C) could lead to lower cost nuclear power plants. What remains is to determine the methodology for duplicating the currently known and documented best cost experience.

3.3 THE COST OF NUCLEAR POWER PLANTS FOR THE 1990's

When the preliminary Phase VI Update cost estimates were reviewed, it became evident that median experience nuclear power plants would be less competitive with coal-fired plants than in previous updates. Consideration was given to developing low cost nuclear power plants based on the best industry experience available. Section 7 discusses the development of cost estimates for nuclear power plants that would come on-line in the 1990's and would duplicate the cost experience of lower cost nuclear power plants coming on-line in the 1980's. The discussion identifies anticipated reductions in the quantities of commodities, manhours and related costs in the median case EEDB nuclear power plants and the conditions under which such reductions might occur.

Table 3-1 presents the 1990's PWR capital cost estimate at the two-digit code-of-accounts level of detail. This estimate is based on a total craft labor content of 14.8 manhours per kilowatt (electrical) and a construction schedule of 90 months. Engineering and field supervision manhours have been reduced to 55 percent and 20 percent respectively of their levels in the Phase VI Update of the PWR. The construction schedule reduction and the craft, engineering and field supervision manhour reductions are based on near best industry experience in these areas coupled with the assumption that the DOE regulatory reform initiative is enacted and that the Phase V (see Appendix C) recommended industry supporting actions are taken. The reduction in field supervision manhours is also based on the reduction in schedule and craft manhours.

The total capital cost of the PWR for the 1990's is $1088/kWe, which gives a PWR/HS8 ratio of 1.3. This is close to the ratio obtained in the Phase I Update (1978), as tabulated in Section 3.2.1 above. In 1978, the PWR was found to be clearly competitive with coal-fired power plants.

TABLE 3-1

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
1139 MWe PRESSURIZED WATER REACTOR NPGS FOR THE 1990's[a]
BASE CONSTRUCTION COSTS
(1983 x 10^6)[b]

Account Number	Account Description	Factory Equip. Costs	Site Labor Cost	Site Material Cost	Total Costs
21	Structures & Improvements	10	95	63	168
22	Reactor Plant Equipment	195	39	14	248
23	Turbine Plant Equipment	156	36	8	200
24	Electric Plant Equipment	29	25	13	67
25	Miscellaneous Plant Equipment	16	17	5	38
26	Main Cond. Heat Reject. System	21	14	3	38
	Total Direct Costs	427	226	106	759
91	Construction Services	55	92	58	205
92	Home Office Engrg. & Services	177	0	0	177
93	Field Office Engrg. & Services	79	8	11	98
	Total Indirect Costs	311	100	69	480
	Total Base Construction Costs	738	326	175	1239
	$/kWe	648	286	154	1088

(a) Based on current industry best cost experience without Owner's Costs, Contingency or AFUDC
(b) Data in January 1, 1983 Constant Dollars

FIGURE 3.1
ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
COMPARISON OF PHASE I (1978), PHASE V (1982) AND PHASE VI (1983)
PWR AND HS 8 BASE CONSTRUCTION COSTS

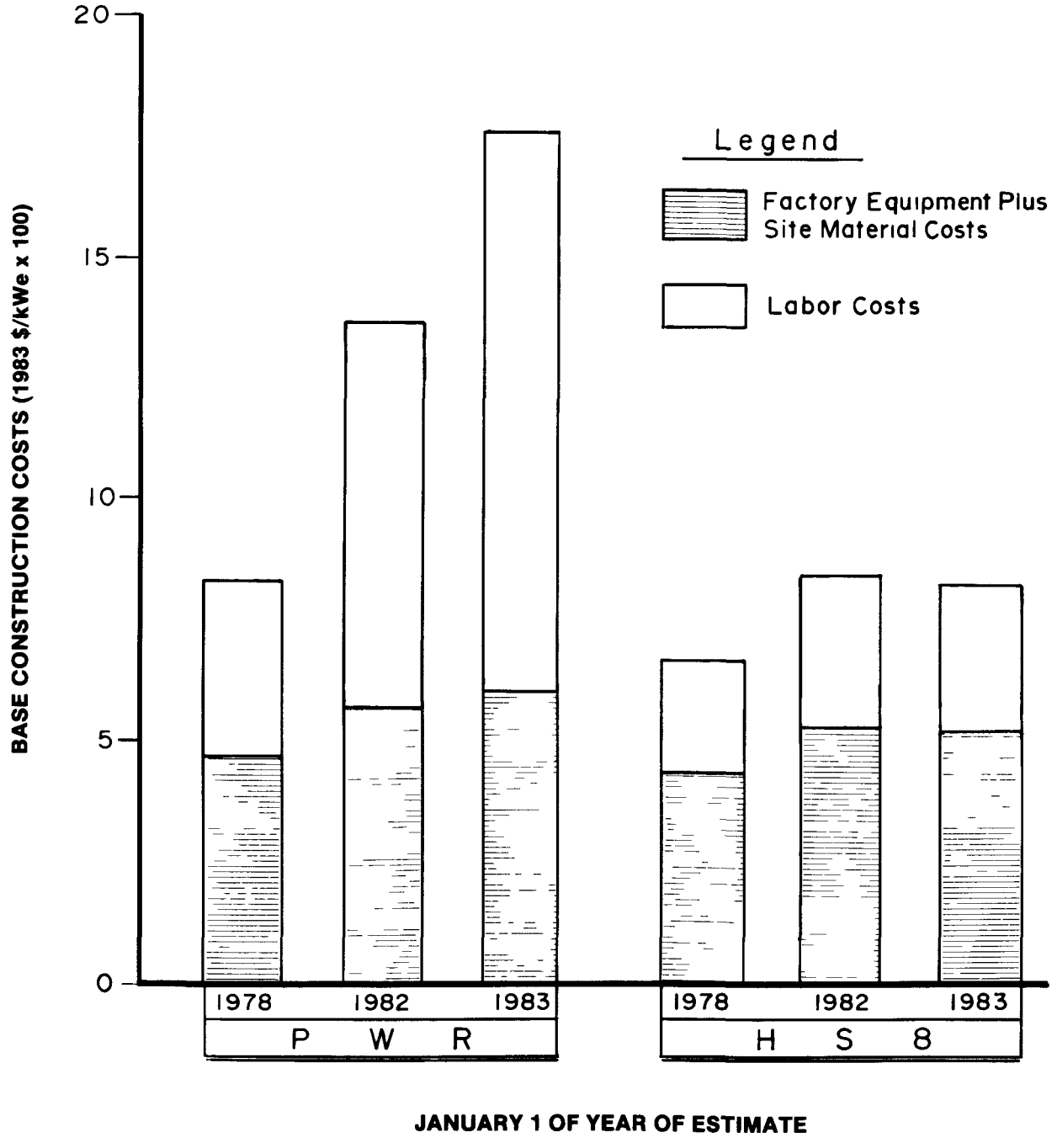


FIGURE 3.2
ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
COMPARISON OF PHASE I (1978), PHASE V (1982) AND PHASE VI (1983)
PWR AND HS 8 FACTORY EQUIPMENT PLUS SITE MATERIAL COST

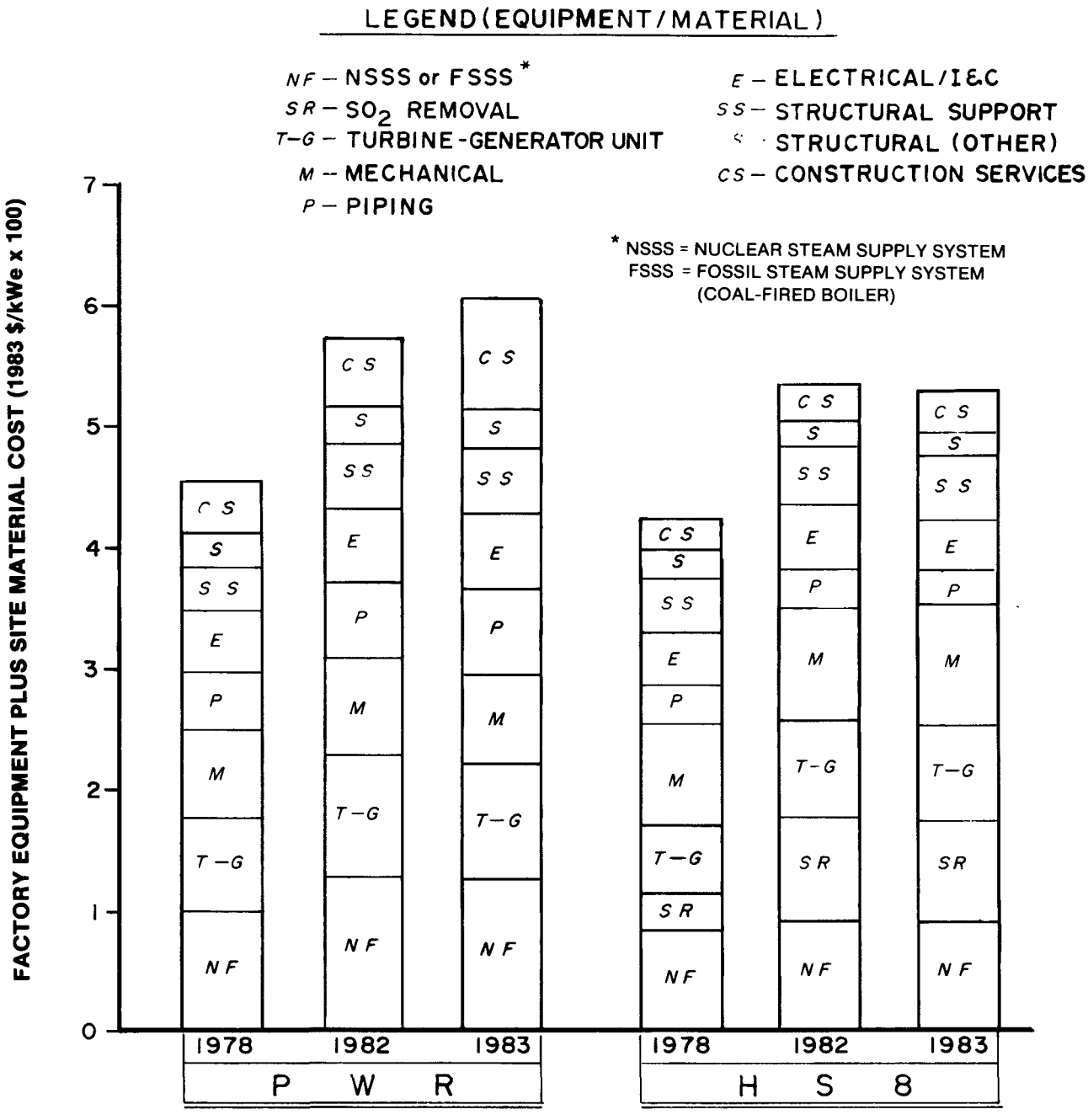
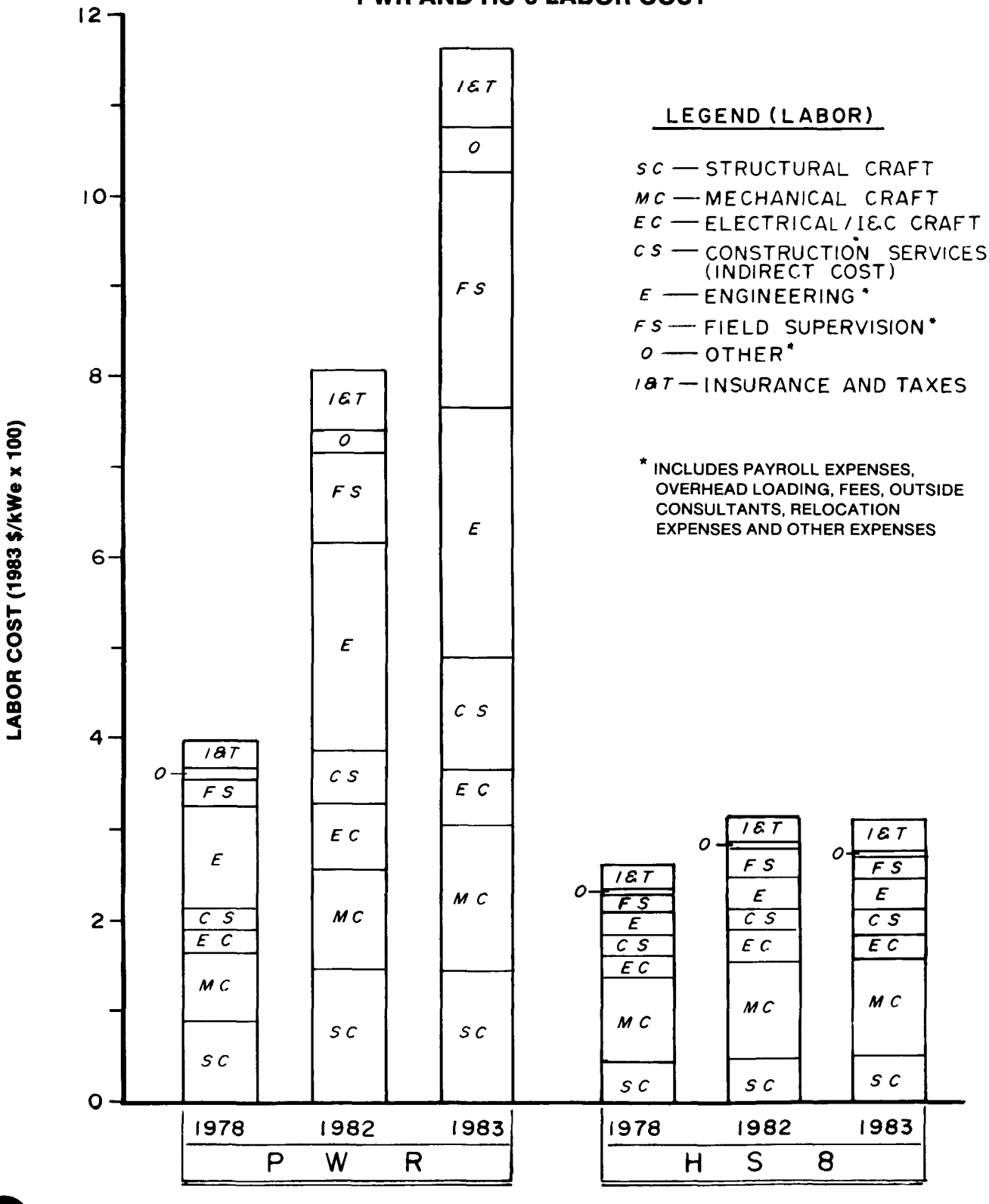


FIGURE 3.3
ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
COMPARISON OF PHASE I (1978), PHASE V (1982) AND PHASE VI (1983)
PWR AND HS 8 LABOR COST



SECTION 4

4.0 TECHNICAL UPDATE FOR SINGLE UNIT NUCLEAR AND COMPARISON POWER PLANTS

The Phase VI Update of the Capital Costs in the EEDB has been accomplished in two distinct steps, in accordance with the EEDB Capital Cost Update Procedure. The first step was the evaluation and adjustment of the technical data models to assure that they reflected current power plant design practice and construction experience (including quantities of commodities, equipment and manhours), and current regulations, codes and standards. The second step was the adjustment of the capital cost data models to accommodate the technical data model revisions and to reflect escalation from the last update. This section of the report presents the detailed results of the changes to the technical data models.

4.1 TECHNICAL DATA MODEL UPDATE PROCEDURE

A specific technical data model update procedure was developed for the EEDB, as a part of the Capital Cost Update Procedure. This procedure is described in Section 6 of the EEDB Program Reference Book.[6] The update procedure is utilized for the selected technical models given in Table 1-2 of this report.

The Phase VI Update performed a Level 2B (nine-digit code-of-accounts level of detail) Technical Update on the PWR, BWR, LMFBR, HS8 and HS5 power plant technical data models. The PWR, BWR, LMFBR and HS8 data models were previously developed to the nine-digit code-of-accounts level of detail. A major task of the Phase VI Update was to develop the HS5 technical data model from the three-digit code-of-accounts level of detail to the nine-digit level.

4.2 TECHNICAL SUMMARY

Summaries of the Phase VI Update quantities of commodities and equipment are given for the PWR, BWR, LMFBR, HS8 and HS5 in Table 4-1. Comparison summaries of Phase V Update (1982) quantities are given in Table 4-2. The installed costs of the commodities/equipment summarized represent approximately 70 to 80 percent of the total direct costs. Approximately 75 to 80 percent of the direct site labor costs are expended in their installation.

The Phase VI Update changes in the quantities of commodities and equipment, as summarized in Tables 4-1 and 4-2, were a direct result of the technical changes described in the following sections. For example, total piping quantities were increased for all of the NPGS as a result of information gained from the long term piping modification review continued during the Phase IV, V and VI Updates, and the various field surveys, conducted during the Phase V and VI Updates.

4.3 TECHNICAL UPDATE RESULTS

The Phase VI technical update supported the EEDB objective of assuring that the technical data models continue to represent current industry design and construction practice at the level established by the Phase V Update. This objective was achieved by comparing commodity, equipment and manhour quanti-

ties for the EEDB technical data models with historical project experience and a growing field survey data bank, in the form of complimentary and parallel studies. The major portion of this effort was expended on the lead reference plants, the PWR and the HS8. The results of the comparison effort on these models was used as a basis to update the other technical models selected for the Phase VI Update.

4.3.1 Review of Impact of Changing Regulations, Codes and Standards

As a first step in the process of updating the technical data models to January 1, 1983, a review of new and revised regulations was conducted. As in the Phase V Update, it was found for the Phase VI Update that changes to existing regulations and promulgation of new regulations occurring since the previous update have had a negligible effect on the quantities of commodities and equipment in the technical data models.

Appendix A contains the results of the EEDB annual NRC Regulatory Guide review. The regulatory guide review identifies new and revised regulatory guides in ten divisions that were promulgated between January 1, 1982 and January 1, 1983. Of the 137 Division 1 (Power Reactors) Regulatory Guides, four were revised. Three of these guides were related to ASME Boiler and Pressure Vessel Code Case Acceptability and the fourth was related to atmospheric dispersion models. Of the 192 Regulatory Guides of Divisions 2 through 10, many of which are not directly applicable to the design and construction of power reactors, two were revised and seven new guides were issued. Of these nine guides, two were related to design while the remainder were either related to operation of or not applicable to power reactors. The two guides related to design provide requirements for the design of independent fuel storage pools (for extended on-site spent fuel storage), which are not utilized for the EEDB nuclear power plant technical data models.

In addition, the following NRC documents were reviewed for changes or additions that occurred between January 1, 1982 and January 1, 1983:

- NRC Standard Review Plans (SRP);
- NRC Inspection and Enforcement (I&E) Bulletins and Circulars; and
- NRC Operating and Construction Experience Bulletins.

The basis for this evaluation was United's "A Compilation of Federal Regulations for the Design and Licensing of Power Plants, Including Engineering Guidelines for Their Implementation" (20 Volumes).

Evaluation of the regulatory guides and other NRC documents indicated that none of the changes or additions to these documents for the period between January 1, 1982 and January 1, 1983 required any specific changes to be made to the technical data models. However, the potential for future significant regulatory induced cost increases for both nuclear and coal-fired power plants remains high. This is primarily due to the level of activity and subjects addressed in the area of formulation of draft regulatory guides and agency rule-making.

Currently, several pending regulatory actions have the potential to cause significant technical changes and related cost increases in the future for both nuclear and coal-fired power plants. In the nuclear area, recently initiated rule-making on universal (mechanical as well as electrical) qualification of equipment important to safety and contemplated rules on mandatory design features to withstand the loss of all a-c power have the potential to cause significant changes in the design features and costs of nuclear power plants. In the fossil area, legislative initiatives on the abatement of acid rain and contemplated control requirements for oxides of nitrogen (NO_x) have the potential to cause significant technical changes and very large cost increases for coal-fired power plants.

4.3.2 Review of Commodities

In the second step of the update process for the technical data models, detailed reviews were made against historical project and current field survey data. The technical data models were reviewed in the areas of structural, piping and electrical quantities of commodities, equipment and manhours. These commodities are the most difficult to estimate because of their complexity and level of detail. Reviews were also made for the Nuclear or Fossil Steam Supply System, the Turbine-Generator Unit, the Flue Gas Cleaning System (coal-fired plants only) and the Heat Rejection System Equipment (Condensers, Cooling Towers). These six or seven items comprise the cost drivers identified in the EEDB Capital Cost Update Procedure for a Level 2B update.

The purpose of the reviews was to assure that the technical data model quantities of commodities and equipment continue to reflect actual industry experience and to continue the technical data model refinement process. It was found that the Phase VI Update quantities given in Table 4-1 for the PWR and BWR lie near the median values for the same commodity/equipment quantities for the 30 power plants currently under construction and over 60 percent complete. Consequently, a major objective of the Phase VI Update, to maintain the technical data models in the condition of being representative of current power plant construction experience is met.

For comparison purposes, the Phase V Update quantities are given in Table 4-2. HS5 quantities only appear in Table 4-1 because the Phase VI Update is the first year that nine-digit level-of-detail is available. The following paragraphs discuss the differences between Tables 4-1 and 4-2.

A detailed structural review was conducted because 1) a comprehensive review of structures and plant configuration had not been done since the data base was assembled in 1978 and 2) the installed cost and craft manhours for the structures represents a major contribution to the plant direct costs. The evaluation and detailed results of the PWR structural review are given in Appendix B.

The results of this review combined with an evaluation of the field survey data led to structural commodity changes between the Phase V and Phase VI updates. Examination of Tables 4-1 and 4-2 show that these changes fell in

the range of ± 10 percent. This level of change by itself is considered to be nominal for the EEDB, because its cost impact is within the error band of the estimate. Therefore, the structural quantity changes were in the nature of a refinement to make the technical data models more representative of industry experience. The LMFBR/BWR changes were based on the PWR changes and also fell into the ± 10 percent range.

A similar review was done for the HS8, but at a lower level of effort. Examination of Tables 4-1 and 4-2 shows that this review resulted in a number of adjustments to conform to current practice. Most of the changes were in the ± 10 percent range. In particular, excavation quantities were added for the coal storage area water runoff control system. Formwork and reinforcing steel were decreased because fill concrete was replaced with earth fill to conform to current practice. Structural concrete, reinforcing steel and formwork were reduced because the coal handling system was changed from a system with major sub-structures to one with a minimum of sub-structure work. These changes also represent refinements to the technical data models that make them more representative of industry experience.

The piping review from the Phase V Update was continued as a refinement of the PWR model with emphasis on the small bore piping. Small bore (< 2 1/2" diameter) instrumentation and compressed air piping was found to be understated relative to current experience. Large bore (≥ 2 1/2" diameter) piping in several small support systems (e.g. Reactor Water Makeup, Chemical and Volume Control, and Condenser Spray Systems) was also increased based on current experience.

These increases in the nuclear power plant piping quantities are representative of the continuing piping increases that are being reported from year-to-year in the field survey data. The specific causes for these individual changes are difficult to identify from field data, primarily because of the way records are traditionally kept. It is believed, however, that the accumulation of such periodically reported changes are caused by the nuclear power plant cost drivers discussed in Section 3.2.2 and Appendix C.

Examination of Tables 4-1 and 4-2 indicates that piping quantities (in lbs.) increased 16 percent for the PWR, 23 percent for the BWR and 11 percent for the LMFBR as a result of these increases. A piping review for the HS8 at a lower level of effort found that the quantity of piping had been slightly overstated relative to current experience. These changes are considered to be improvements in the accuracy of the estimate.

A detailed electrical equipment review was conducted because 1) a comprehensive electrical plant review had not been done since the data base was assembled and 2) the installed cost and installation manhours for the electric equipment represent a significant contribution to the plant direct costs. In this review it was found from the field survey data that nuclear plant cable and raceway quantities had continued to increase since the Phase V Update.

Adjustments were made that resulted in an increase of approximately 25 percent for cable and 15 percent for raceways in the nuclear power plants. It is speculated that the higher rate of increase for the cables either reflects

underestimates based on early and incomplete information or a growing conservatism relative to either the raceway loading density or the quantities of spare wires. As in the case of the piping changes, specific causes for individual changes were difficult to determine from the field data. It is believed that these changes are also caused by the nuclear power plant cost drivers mentioned above.

A similar review was made for the HS8. In this case it was found that cable and raceway quantities were overstated by approximately nine percent relative to current experience.

Tables 4-1 and 4-2 reflect all of the changes discussed above.

A review of the Other Cost Drivers (Steam Supply System, Turbine-Generator Unit, Flue Gas Cleaning System and Heat Exchangers) indicated minor changes associated with these items. In most cases, these changes were caused by equipment price changes. Tables 4-1 and 4-2 reflect this on a dollar per kilowatt basis. These cost changes are discussed further in Section 5.

4.3.3 Extension of the HS5 Level of Detail

During the Phase VI Update, the HS5 level of detail was extended from the three-digit to the nine-digit code-of-accounts. This activity was based on the updated HS8. Detailed commodity, manhour and cost information was available for the HS5 in the Phase VI Update data tables for the first time. As a first step in this activity, a plot plan, heat balance diagram and a set of summary system descriptions were prepared for the HS5 at the three-digit code-of-accounts level of detail. This information was included in the EEDB Technical Reference Book.[7] The extension was accomplished by using the above documents as guidance to make adjustments to the updated HS8 equipment list (PEGASUS) mini-specifications, system parameters, quantities of commodities, equipment, and manhours and unit equipment costs to reflect the detailed design features of the HS5.

4.3.4 Review of Manhours

In the Phase VI Update, quantities of craft, engineering and field supervision manhours were based on project experience and current field survey data. In reviewing the field survey data, it was found that nuclear power plant quantities of manhours have risen rapidly between the Phase V and Phase VI Updates. The data indicated that the ranges of manhours from low to high have widened considerably over the last year. The data also showed that there is little correlation between reported construction schedule length and quantities of manhours or base construction cost.

Because of the manner in which manhours are monitored and tabulated, the field survey data and supplemental discussions with utilities were unable to identify specific causes for manhours increases from the Phase V to the Phase VI Updates. Some utilities are now accumulating regulatory issue related work and craft rework hours separately and attempting to identify reasons for the work. This is not yet a widespread practice and has not been applied to

engineering and field supervision hours. From the data that are available, however, it may be inferred that the cost drivers discussed in Section 3.2.2 and Appendix C are still operational and increasing in degree of impact. While units with good cost, schedule and manhour experience are reporting rising manhours at a moderate rate, units with poorer experience are reporting that manhours are increasing at an increasingly rapid rate. This accounts for the increasing spread in the ranges of manhours from low to high.

Table 4-3 tabulates manhours for 14 PWR nuclear power plants under construction but at least 60 percent complete on January 1, 1983. The units range in size from approximately 1100 MWe to nearly 1300 MWe. They are single units or first units on a site (single unit plus common facilities). Their range of costs is over 1:1.9. Their range of construction schedules is 1:1.6. Their range of craft, engineering and field supervision manhours is 1:2.2, 1:6.8 and 1:8.7 respectively. The field survey also showed wide ranges of unit manhours (craft manhours per unit of commodity or equipment).

For the Phase VI Update, the unit manhours were adjusted based on project experience, which generally agreed with the median industry experience. The data were input at the six- to nine-digit code-of-accounts level of detail. The result of the PWR update was a craft manhour level of 26 manhours per kilowatt, about four percent higher than the industry survey median. Engineering and field supervision manhours were also based on project experience and once again agreed well with median industry experience.

4.4 DETAILED TECHNICAL CHANGES

The EEDB Technical Reference Book,[7] prepared during the Phase VI Update, contains the base data for each of the technical data models updated. The base data is in the form of assumptions, ground-rules, design criteria, system design descriptions and engineering drawings.

This section describes the modifications made to the Phase V technical data models required for the Phase VI Update and preparation of the Technical Reference Book. Commodities, equipment and craft labor manhours resulting from this update are tabulated for each of the selected technical data models in Tables 4-4 through 4-8 as follows:

Nuclear Plant Models	Table Number	Fossil Plant Models	Table Number
PWR	4-4	HS8	4-7
BWR	4-5	HS5	4-8
LMFBR	4-6		

The nature of these changes and the general reasons for their occurrence is discussed in Section 4.3 above.

The following pages discuss the specific technical data model modifications made during the Phase VI Update. The discussions of these modifications are given at the three-digit code-of-accounts level of detail. For convenience, the discussion of each technical data model is started at the top of a new page.

4.4.1 EEDB Data Model Number A3, Type PWR, EEDB Phase VI (1983) Update
EEDB Data Model Number A1, Type BWR, EEDB Phase VI (1983) Update
EEDB Data Model Number A5, Type LMFBR, EEDB Phase VI (1983) Update

The following technical data model modifications are common to all of the nuclear power generating stations selected for the Phase VI Update. These modifications take the form of changes in quantities of commodities and equipment and their installation manhours, which are an integral part of the technical data models. The changes are based on current design and construction practice as reflected in the Phase VI structural, piping and electrical reviews, the concurrent field surveys and United Engineers' experience.

ACCOUNT 211 Yardwork

Manhours were increased for general cut and fill and for sanitary sewer facilities based upon current experience. Trench excavation and backfill were added as a result of the structural review (see Appendix B).

ACCOUNT 21X Structures & Improvements

Structural commodity quantities for each building were updated in accordance with the structural review, which caused changes in formwork, concrete and steel. The structural review also resulted in associated increases in painting, drains and related piping, HVAC ductwork, and lighting/service power.

ACCOUNT 218Z Waste Water Treatment Building

A new building was added as part of the waste water treatment equipment modification in Account 255.

ACCOUNT 22X Reactor Plant Equipment

Two accounts were deleted from the technical data models because their functions were incorporated into other accounts; the accounts were for pipe whip restraints and for final alignment and checking. This change was made to conform with current practice.

ACCOUNT 24X Electric Plant Equipment

Cable and raceway quantities were increased to reflect current experience. It is believed that most of this increase was due to rework caused by field interferences or redesign to satisfy changing interpretations of separation and other regulatory requirements.

ACCOUNT 25X Miscellaneous Plant Equipment

Piping quantities were updated in accordance with the piping review. The largest increase was in small bore pipe associated with the compressed air

(primarily instrumentation) system; increases in other piping quantities and in the installation time per pound of pipe throughout the account contributed significantly to the overall increase in the installation manhours. The small bore pipe change was caused by using better data to update an initial estimate. The other changes were caused by the continuation of reinterpretation of regulations, and the associated redesign, rework and declining productivity.

ACCOUNT 255 Waste Water Treatment Equipment

Equipment was added for treating non-nuclear contaminated, aqueous wastes before these waters are recycled within the plant or discharged to the North River. The effluent from this equipment is normally recycled within the plant. This addition was made to comply with the latest EEDB evaluation of EPA guidelines relative to the Clean Water Act of 1977. A revision is also made to Account 218Z in support of this change.

4.4.2 EEDB Data Model Number C2, Type HS8, EEDB Phase VI (1983) Update

The HS8 technical data model received major modifications in the coal handling system and in the waste water treatment equipment. The coal handling system was changed from a lowering well/rotary plow design to a more automated stacker-reclaimer system. This change provided a more suitable design for the "hard rock" Middletown site. The waste water treatment equipment design was changed to reflect current practice and latest interpretation of environmental regulations. The following technical data model modifications reflect these and other changes for the HS8.

ACCOUNT 211 Yardwork

The quantities of concrete fill were reduced to reflect current practice.

ACCOUNT 218L Stacker-Reclaimer Transfer Tower

The stacker-reclaimer transfer tower was added as part of the coal handling system modification in Account 224.

ACCOUNT 218R Dead Storage Transfer Tunnel

The dead storage transfer tunnel was added as part of the coal handling system modification in Account 224. This replaced the "Rotary Plow Maintenance Shed" which was previously in this account. The rotary plow maintenance shed was deleted as part of the coal handling system modification in Account 224.

ACCOUNT 218W Miscellaneous Coal Handling Structures

The miscellaneous coal handling structures account was revised as part of the coal handling system modification in Account 224. Items deleted included the rotary plow access tunnel and the lowering wells. Miscellaneous structural work related to the stacker-reclaimer and a maintenance and repair shop were added.

ACCOUNT 224 Fuel Handling System

The fuel handling system was changed from a lowering well/rotary plow design to a stacker-reclaimer system. The stacker-reclaimer is designed for a stack-out rate of 2000 tons of coal per hour and a reclaim rate of 550 tons of coal per hour. Revisions are also made to Accounts 211, 218L, 218R, and 218W in support of this change. The fuel handling system had not been reviewed since 1978. Evaluation of the fuel handling system design approach relative to the "Middletown" site characteristics, costs of alternative systems and current practice led to a decision to make this change.

ACCOUNT 228 Boiler Plant Miscellaneous Items

The boiler plant miscellaneous items account was modified by the deletion of final alignment and checking, which are now accounted for elsewhere.

ACCOUNT 252 Air, Water, and Steam Service Systems Account

Additional sprinkler systems and fire hose cabinets were added in several buildings. The fire protection system had not been evaluated since 1978. Review of this system found several deficiencies relative to current regu-regulations.

ACCOUNT 253 Communication Equipment

Additional communication and security equipment was provided to be consistent with current practice.

ACCOUNT 255 Waste Water Treatment Equipment

The waste water treatment equipment was modified to reflect the updated waste water treatment system design. The updated design was sized to treat all plant waste water except for drainage from the flue gas desulfurization system. Two 1,100,000 gallon equalization basins were provided, in lieu of two 1,350,000 gallon holding tanks. A third 750,000 gallon basin was also provided for receiving metal cleaning wastes. These modifications were made to comply with the latest EEDB evaluation of EPA guidelines relative to the Clean Water Act of 1977.

ACCOUNT 261 Structures

The size of the intake structure was increased by the addition of a bay for the fire water pumps. The cooling tower switchgear building was added to house the switchgear in the cooling tower area. These additions were made to correct technical data model deficiencies relative to current practice.

4.4.3 EEDB Data Model Number D2, Type HS5, EEDB Phase VI (1983) Update

During the Phase VI Update, the HS5 technical data model was expanded to the nine-digit code-of-accounts level of detail using the updated (modified per Section 4.4.2) HS8 as a basis. However, the coal handling system was converted from a stacker/rotary plow design to a stacker-reclaimer system to be consistent with the HS8. The following technical data model modifications reflect these changes for the HS5.

ACCOUNT 218L Stacker-Reclaimer Transfer Tower

The stacker-reclaimer transfer tower was added as part of the coal handling system modification in Account 224. This replaces the "Stacker Transfer Tower" which was previously in this account.

ACCOUNT 2180 Coal Breaker House

The coal breaker house was added as part of the coal handling system modification in Account 224. This replaces the "Dead Storage Reclaim Hopper" which was previously in this account. The dead storage reclaim hopper was replaced by the dead storage transfer tunnel as part of the coal handling system modification in Account 224.

ACCOUNT 224 Fuel Handling System

The fuel handling system was changed from a stacker/rotary plow design to a stacker-reclaimer system. The stacker-reclaimer is designed for a stack-out rate of 2000 tons of coal per hour and a reclaim rate of 550 tons of coal per hour. This change was made for the reasons previously discussed for the HS8. Revisions were also made to Accounts 218L and 2180 in support of this change.

In addition to these changes, the HS5 technical data model was expanded from 50 systems to about 400 systems and provided with individual equipment list mini-specifications at the nine-digit code-of-accounts level of detail. During this process, all of the Phase VI Update changes to the HS8 described in Section 4.4.2 were incorporated into the HS5.

TABLE 4-1

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
COMMODITY/EQUIPMENT SUMMARY FOR NUCLEAR AND COMPARISON POWER GENERATING STATIONS

Model/Rating (MWe)		PWR/1139	BWR/1190	LMFBR/1457	HS8/791	HS5/486
Commodity/Equipment	Unit[a]	Commodities (Quantity x 10^{3}[b])				
Excavation	CY	668	676	924	303	233
Formwork	SF	2,123	2,707	2,748	774	604
Reinforcing, Embedded and Structural Steel	TN	40	44	61	24	19
Structural Concrete	CY	172	225	262	88	63
BOP Pumps[c] (1000 HP and Above)	HP	56	54	99	49	23
Piping[d]	LB	10,721	10,750	12,055	5,262	4,011
Raceways	LF	725	739	1,202	526	445
Wire and Cable	LF	6,275	6,277	8,800	3,105	2,660
		Equipment ($/kWe[e])				
Steam Supply System	LT	130	119	309	111	128
Coal and Ash Handling	LT	N/A	N/A	N/A	35	50
Precipitator and Scrubber[f]	LT	N/A	N/A	N/A	120	161
Turbine-Generator	LT	98	95	87	80	91
Heat Exchangers[g]	LT	38	34	32	24	27
Inst. and Control	LT	29	29	21	12	17

(a) CY = Cubic Yards; LB = Pounds; LF = Linear Feet; LT = Lot; HP = Horsepower; SF = Square Feet; TN = Ton
(b) Rounded Off to the Nearest 1,000 Units
(c) Includes Boiler Feed Pumps
(d) Includes Carbon Steel and Stainless Steel Piping for BWR, PWR, LMFBR, HS8 and HS5 and Chrome-Moly Piping for LMFBR, HS8 and HS5
(e) Data in January 1, 1983 Constant Dollars
(f) Does Not Include Commodities for Structures or Building and Equipment Foundations, Piping, HVAC, I&C, or Electrical Equipment for Scrubber
(g) Includes Condensers and Cooling Towers
N/A = Not Applicable

TABLE 4-2

ENERGY ECONOMIC DATA BASE
PHASE V UPDATE
COMMODITY/EQUIPMENT SUMMARY FOR NUCLEAR AND COMPARISON POWER GENERATING STATIONS[a]

Model/Rating (MWe)		PWR/1139	BWR/1190	LMFBR/1457	HS8/795
Commodity/Equipment	Unit[b]	Commodities (Quantity x 10^3[c])			
Excavation	CY	601	609	844	225
Formwork	SF	2,355	2,699	2,701	939
Reinforcing, Embedded and Structural Steel	TN	39	41	61	26
Structural Concrete	CY	172	210	261	95
BOP Pumps[d] (1000 HP and Up)	HP	56	54	99	49
Piping[e]	LB	9,275	8,771	10,904	5,435
Raceways	LF	624	635	1,007	575
Wire and Cable	LF	5,075	5,027	7,140	3,423
		Equipment ($/kWe[f])			
Steam Supply System	LT	125	116	301	105
Coal and Ash Handling	LT	N/A	N/A	N/A	23
Precipitator and Scrubber[g]	LT	N/A	N/A	N/A	112
Turbine-Generator	LT	98	95	86	78
Heat Exchangers[h]	LT	39	36	33	30
Inst. and Control	LT	28	28	20	11

(a) HS5 Data Not Available for Phase V Update
(b) CY = Cubic Yards; LB = Pounds; LF = Linear Feet; LT = Lot; HP = Horsepower; SF = Square Feet; TN = Tons
(c) Rounded Off to the Nearest 1,000 Units
(d) Includes Boiler Feed Pumps
(e) Includes Carbon Steel and Stainless Steel Piping for BWR, PWR, LMFBR and HS8 and Chrome-Moly Piping for LMFBR and HS8
(f) Data in January 1, 1982 Constant Dollars
(g) Does Not Include Commodities for Structures or Building and Equipment Foundations, Piping, HVAC, I&C, or Electrical Equipment for Scrubber
(h) Includes Condensers and Cooling Towers
N/A = Not Applicable

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

PWR FIELD SURVEY RESULTS
COST, SCHEDULE AND MANHOUR COMPARISON

Unit[a]	Percent Complete	BCC[b] $1983/kWe	Construction Schedule[c]	Manhours[d] Craft (MH/kWe)	Manhours[d] Engineering (MH/kWe)	Manhours[d] Field Supervision (MH/kWe)
1	68	1399	107 M	14	1.8	1.7
2	93	1400	107	20	7.5	12.8
3	93	1571	110	31	N/A	11.0
4	99	1657	90	18	3.8	4.9
5	89	1713	110	15	4.5	2.2
6	81	1781	95	25 M	7.0	11.6
7	83	1839	140	27	5.6	10.0
8	92	1933 M	135	26	4.2	9.3
9	73	2061	95	30	12.2	10.3
10	94	2100	94	22	9.1	9.6 M
11	88	2222	100	26	7.0 M	14.8
12	100	2400	94	15	6.0	7.5
13	60	2570	115	25	12.2	8.5
14	73	2614	110	23	N/A	N/A

(a) 1100 MWe to 1300 MWe, Single or First-on-Site Units
(b) Reported Base Construction Cost as of January, 1983
(Data in January 1, 1983 Constant Dollars Without AFUDC, but Including Contingency, Owner's Costs, Taxes Other Than Payroll, Fees, Permits and Licenses, Switchyard Cost and Generator Step-Up Transformer Cost)
(c) Less Deliberate Delay Months
(d) Reported Manhours as of March, 1983

N/A = Not Available
M = Median

TABLE 4-4

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
COMMODITY AND CRAFT MANHOUR SUMMARY
1139 MWe PRESSURIZED WATER REACTOR NUCLEAR POWER GENERATING STATION

NUCLEAR PLANT QUANTITIES

Commodity	Unit[a]	Quantity	Installed Cost/Unit[b]
Excavation (Rock/Earth)	CY	668,188	11.50
Fill	CY	400,451	7.21
Formwork	SF	2,123,374	18.00
Reinforcing Steel	TN	26,902	1,721.00
Structural Concrete	CY	172,033	116.75
Concrete Fill	CY	104,822	67.88
Embedded Steel	TN	1,926	9,626.00
Structural Steel	TN	10,839	2,312.00
Special Steel Liners	LT	--	21.82[c]
Carbon Steel Piping (NS)	LB	2,133,148	17.26
Stainless Steel Piping (NS)	LB	729,560	53.67
Carbon Steel Piping (NNS)	LB	7,280,565	11.13
Stainless Steel Piping (NNS)	LB	577,517	39.84
Valves	LT	--	15.27[c]
Fire Protection	LT	--	6.09[c]
BOP Pumps (1000 HP & above)[d]	HP	55,500	121.88
Heat Exchangers	LT	--	38.05[c]
Turbine Generator	LT	--	98.20[c]
Instrumentation and Control	LT	--	28.85[c]
Heat., Ventilating, & Air Cond.	LT	--	11.05[c]
Lighting & Service Power	LT	--	5.81[c]
Duct Runs and Wire Containers	LF	724,600	41.92
Wire and Cable	LF	6,274,500	4.21
Electrical Balance of Plant	LT	--	30.18[c]
Nuclear Steam Supply System	LT	--	130.00[c]
All Others[e]	LT	--	129.61[c]

NUCLEAR PLANT MANHOURS

Craft	Manhours	Cost x 10^3[b]
Boiler Makers	988,245	20,061.
Bricklayers	309,702	5,485.
Carpenters	1,743,860	33,831.
Electricians	3,668,965	73,783.
Ironworkers	2,458,954	49,917.
Laborers	2,389,940	36,112.
Millwrights	263,040	5,537.
Operating Engineers	1,548,236	28,488.
Painters	773,939	11,617.
Pipe Fitters	6,412,699	134,538.
Sheet Metal Workers	208,034	4,296.
Teamsters	337,525	4,675.
All Others	272,343	5,587.
Total Craft Labor[f]	21,375,482	413,927.

(a) CY = Cubic Yards; LB = Pounds; LF = Linear Feet; LT = Lot; HP = Horsepower; SF = Square Feet; TN = Tons
(b) Data in January 1, 1983 Constant Dollars
(c) Cost per Unit is in Dollars per Kilowatt - Electrical ($/kWe)
(d) Includes Boiler Feed Pumps
(e) Does Not Inlcude Indirect Costs
(f) Does Not Include Indirect Manhours

(NNS) = Non-Nuclear Safety Grade
(NS) = Nuclear Safety Grade

TABLE 4-5

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
COMMODITY AND CRAFT MANHOUR SUMMARY
1190 MWe BOILING WATER REACTOR NUCLEAR POWER GENERATING STATION

NUCLEAR PLANT QUANTITIES

Commodity	Unit[a]	Quantity	Installed Cost/Unit[b]
Excavation (Rock/Earth)	CY	676,328	11.41
Fill	CY	399,179	7.22
Formwork	SF	2,707,466	17.24
Reinforcing Steel	TN	30,781	1,689.00
Structural Concrete	CY	225,490	114.66
Concrete Fill	CY	106,347	68.03
Embedded Steel	TN	2,346	9,626.00
Structural Steel	TN	10,910	2,312.00
Special Steel Liners	LT	--	37.45[c]
Carbon Steel Piping (NS)	LB	2,741,554	17.46
Stainless Steel Piping (NS)	LB	94,196	42.58
Carbon Steel Piping (NNS)	LB	7,487,192	11.08
Stainless Steel Piping (NNS)	LB	426,960	39.97
Valves	LT	--	16.83[c]
Fire Protection	LT	--	5.87[c]
BOP Pumps (1000 HP & above)[d]	HP	54,400	115.55
Heat Exchangers	LT	--	34.70[c]
Turbine Generator	LT	--	95.30[c]
Instrumentation and Control	LT	--	29.38[c]
Heat., Ventilating, & Air Cond.	LT	--	11.38[c]
Lighting & Service Power	LT	--	5.40[c]
Duct Runs and Wire Containers	LF	738,500	41.84
Wire and Cable	LF	6,277,000	4.25
Electrical Balance of Plant	LT	--	31.15[c]
Nuclear Steam Supply System	LT	--	119.33[c]
All Others[e]	LT	--	132.43[c]

NUCLEAR PLANT MANHOURS

Craft	Manhours	Cost x 10^3[b]
Boiler Makers	558,028	11,328.
Bricklayers	392,810	6,957.
Carpenters	2,030,439	39,391.
Electricians	3,741,322	75,238.
Ironworkers	2,961,335	60,115.
Laborers	2,662,899	40,236.
Millwrights	337,379	7,102.
Operating Engineers	1,785,915	32,861.
Painters	935,953	14,049.
Pipe Fitters	6,408,808	134,457.
Sheet Metal Workers	394,830	8,153.
Teamsters	374,040	5,180.
All Others	276,918	5,681.
TOTAL CRAFT LABOR[f]	22,860,676	440,748.

(a) CY = Cubic Yards; LB = Pounds; LF = Linear Feet; LT = Lot; HP = Horsepower; SF = Square Feet; TN = Tons
(b) Data in January 1, 1983 Constant Dollars
(c) Cost per Unit is in Dollars per Kilowatt - Electrical ($/kWe)
(d) Includes Boiler Feed Pumps
(e) Does Not Include Indirect Costs
(f) Does Not Include Indirect Manhours

(NNS) = Non-Nuclear Safety Grade
(NS) = Nuclear Safety Grade

TABLE 4-6

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
COMMODITY AND CRAFT MANHOUR SUMMARY
1457 MWe LIQUID METAL FAST BREEDER REACTOR NUCLEAR POWER GENERATING STATION

NUCLEAR PLANT QUANTITIES

Commodity	Unit[a]	Quantity	Installed Cost/Unit[b]
Excavation (Rock/Earth)	CY	924,362	13.54
Fill	CY	259,371	10.16
Formwork	SF	2,748,480	16.58
Reinforcing Steel	TN	42,575	1,817.00
Structural Concrete	CY	261,999	121.22
Concrete Fill	CY	130,377	67.30
Embedded Steel	TN	2,589	9,570.00
Structural Steel	TN	16,310	2,312.00
Special Steel Liners	LT	--	39.09[c]
Carbon Steel Piping (NS)	LB	745,162	16.12
Stainless Steel Piping (NS)	LB	763,866	80.02
Carbon Steel Piping (NNS)	LB	7,862,037	11.15
Stainless Steel Piping (NNS)	LB	1,022,798	38.88
Chrome-Moly Piping (NNS)	LB	1,661,630	13.14
Valves	LT	--	11.14[c]
Fire Protection	LT	--	4.42[c]
BOP Pumps (1000 HP & above)[d]	HP	98,600	80.54
Heat Exchangers	LT	--	31.82[c]
Turbine Generator	LT	--	86.79[c]
Instrumentation and Control	LT	--	21.22[c]
Heat., Ventilating, & Air Cond.	LT	--	18.30[c]
Lighting & Service Power	LT	--	7.98[c]
Duct Runs and Wire Containers	LF	1,201,600	38.19
Wire and Cable	LF	8,799,500	4.22
Electrical Balance of Plant	LT	--	25.06[c]
Nuclear Steam Supply System	LT	--	308.97[c]
All Others[e]	LT	--	129.20[c]

NUCLEAR PLANT MANHOURS

Craft	Manhours	Cost x 10^3[b]
Boiler Makers	1,395,470	28,328.
Bricklayers	439,695	7,787.
Carpenters	2,185,553	42,400.
Electricians	5,409,319	108,781.
Ironworkers	4,238,886	86,049.
Laborers	3,284,695	49,632.
Millwrights	393,217	8,277.
Operating Engineers	2,323,343	42,750.
Painters	1,073,022	16,106.
Pipe Fitters	8,644,386	181,359.
Sheet Metal Workers	404,245	8,348.
Teamsters	485,500	6,724.
All Others	395,813	8,261.
TOTAL CRAFT LABOR[f]	30,673,144	594,802.

(a) CY = Cubic yards; LB = Pounds; LF = Linear Feet; LT = Lot; HP = Horsepower; SF = Square Feet; TN = Tons
(b) Data in January 1, 1983 Constant Dollars
(c) Cost per Unit is in Dollars per Kilowatt - Electrical ($/kWe)
(d) Includes Boiler Feed Pumps
(e) Does Not Include Indirect Costs
(f) Does Not Include Indirect Manhours

(NNS) = Non-Nuclear Safety Grade
(NS) = Nuclear Safety Grade

TABLE 4-7

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
COMMODITY AND CRAFT MANHOUR SUMMARY
791 MWe HIGH SULFUR COAL-FIRED POWER GENERATING STATION

COMPARISON COAL PLANT QUANTITIES

Commodity	Unit[a]	Quantity	Installed Cost/Unit[b]
Excavation (Rock/Earth)	CY	303,220	7.08
Fill	CY	77,926	7.81
Formwork	SF	774,496	9.62
Reinforcing Steel	TN	5,947	1,194.00
Structural Concrete	CY	87,975	74.87
Concrete Fill	CY	6,882	64.12
Embedded Steel	TN	355	6,680.00
Structural Steel	TN	18,148	1,567.00
Carbon Steel Piping	LB	4,017,818	7.16
Stainless Steel Piping	LB	600	21.47
Chrome-Moly Piping	LB	1,243,697	8.74
Valves	LT	--	4.96[c]
Fire Protection	LT	--	2.56[c]
Pumps (1000 HP & above)[d]	HP	48,700	70.63
Heat Exchangers	LT	--	24.21[c]
Turbine Generator	LT	--	80.30[c]
Coal Handling[e]	LT	--	28.99[c]
Electrostatic Precipitator	LT	--	20.48[c]
SO_2 Removal[f]	LT	--	99.53[c]
Ash Handling	LT	--	6.26[c]
Instrumentation and Control	LT	--	11.63[c]
Heat., Ventilating, & Air Cond.	LT	--	5.50[c]
Lighting & Service Power	LT	--	3.96[c]
Duct Runs & Wire Containers	LF	526,100	19.33
Wire and Cable	LF	3,105,160	3.09
Electrical Balance of Plant	LT	--	22.85[c]
Fossil Steam Supply System	LT	--	111.02[c]
All Others[g]	LT	--	103.69[c]

COMPARISON COAL PLANT MANHOURS

Craft	Manhours	Cost x 10^3[b]
Boiler Makers	881,911	17,902.
Bricklayers	97,927	1,734.
Carpenters	337,437	6,546.
Electricians	1,188,110	23,893.
Ironworkers	698,657	14,183.
Laborers	643,326	9,721.
Millwrights	235,760	4,963.
Operating Engineers	460,938	8,481.
Painters	204,401	3,068.
Pipe Fitters	2,278,286	47,798.
Sheet Metal Workers	58,342	1,205.
Teamsters	91,650	1,269.
All Others	118,922	2,548.
TOTAL CRAFT LABOR[h]	7,295,667	143,311.

(a) CY = Cubic Yards; LB = Pounds; LF = Linear Feet; LT = Lot; HP = Horsepower; SF = Square Feet; TN = Tons
(b) Data in January 1, 1983 Constant Dollars
(c) Cost per Unit is in Dollars per Kilowatt - Electrical ($/kWe)
(d) Includes Boiler Feed Pumps
(e) Does Not Include Ignition Oil System
(f) Does Not Include Commodities for Structures or Buildings and Equipment Foundations, Piping, HVAC, I&C, or Electrical Equipment (Cost per Unit is $138.40/kWe when Piping and Structural Commodities are Included)
(g) Does Not Include Indirect Costs
(h) Does Not Include Indirect Manhours

TABLE 4-8

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
COMMODITY AND CRAFT MANHOUR SUMMARY
486 MWe HIGH SULFUR COAL-FIRED POWER GENERATING STATION

COMPARISON COAL PLANT QUANTITIES

Commodity	Unit[a]	Quantity	Installed Cost/Unit[b]
Excavation (Rock/Earth)	CY	232,684	6.89
Fill	CY	65,680	8.77
Formwork	SF	604,154	9.68
Reinforcing Steel	TN	4,235	1,170.00
Structural Concrete	CY	62,696	77.22
Concrete Fill	CY	4,752	66.74
Embedded Steel	TN	217	6,670.00
Structural Steel	TN	14,398	1,567.00
Carbon Steel Piping	LB	3,286,734	7.16
Stainless Steel Piping	LB	600	21.47
Chrome-Moly Piping	LB	724,150	8.75
Valves	LT	--	6.05[c]
Fire Protection	LT	--	3.55[c]
Pumps (1000 HP & above)[d]	HP	23,400	88.32
Heat Exchangers	LT	--	27.41[c]
Turbine Generator	LT	--	90.83[c]
Coal Handling[e]	LT	--	41.49[c]
Electrostatic Precipitator	LT	--	23.56[c]
SO_2 Removal[f]	LT	--	137.60[c]
Ash Handling	LT	--	8.17[c]
Instrumentation and Control	LT	--	17.34[c]
Heat., Ventilating, & Air Cond.	LT	--	6.53[c]
Lighting & Service Power	LT	--	4.10[c]
Duct Runs & Wire Containers	LF	444,800	19.22
Wire and Cable	LF	2,660,000	3.06
Electrical Balance of Plant	LT	--	33.93[c]
Fossil Steam Supply System	LT	--	127.59[c]
All Others[g]	LT	--	121.39[c]

COMPARISON COAL PLANT MANHOURS

Craft	Manhours	Cost x 10^3[b]
Boiler Makers	660,978	13,418.
Bricklayers	65,780	1,165.
Carpenters	230,253	4,467.
Electricians	987,792	19,864.
Ironworkers	497,193	10,093.
Laborers	490,218	7,407.
Millwrights	176,665	3,719.
Operating Engineers	347,409	6,392.
Painters	160,724	2,412.
Pipe Fitters	1,708,549	35,845.
Sheet Metal Workers	36,091	745.
Teamsters	67,990	942.
All Others	296,750	5,549.
TOTAL CRAFT LABOR[h]	5,726,392	112,018.

(a) CY = Cubic Yards; LB = Pounds; LF = Linear Feet; LT = Lot; HP = Horsepower; SF = Square Feet; TN = Tons
(b) Data in January 1, 1983 Constant Dollars
(c) Cost per Unit is in Dollars per Kilowatt - Electrical ($/kWe)
(d) Includes Boiler Feed Pumps
(e) Does Not Include Ignition Oil System
(f) Does Not Include Commodities for Structures or Building and Equipment Foundations, Piping, HVAC, I&C, or Electrical Equipment (Cost per Unit is $169.04/kWe when Piping and Structural Commodities are Included).
(g) Does Not Include Indirect Costs
(h) Does Not Include Indirect Manhours

SECTION 5

5.0 CAPITAL COST UPDATE FOR SINGLE UNIT NUCLEAR AND COMPARISON POWER PLANTS

As stated in Section 4, the Phase VI Update of the Capital Costs in the EEDB has been accomplished in two steps. Section 4 presents the results of the first step, which was the evaluation and adjustment of the technical data models selected for the update. This section of the report presents the results of the second step, which was the adjustment of the capital cost data models to accommodate the technical data model revisions and to reflect the effects of inflation since the Phase V Update.

5.1 CAPITAL COST DATA MODEL UPDATE PROCEDURE

A specific capital cost update procedure was developed for the EEDB during the Phase I Update in 1978, which includes both the technical and capital cost update steps. This procedure is described in Section 6 of the EEDB Program Reference Book.[6] The Phase VI Update utilized a Level 2 (nine-digit code-of-accounts level of detail) Capital Cost Update for the PWR, BWR, LMFBR, HS8 and HS5, in conjunction with their Level 2B Technical Updates discussed in Section 4.

In the Phase VI Update, commodity and equipment costs were updated to January 1, 1983, in accordance with the applicable specifications for Level 2 Capital Cost Updates. The following new cost information was obtained for the Level 2 Update:

- manufacturer estimating quotations for the nuclear and fossil steam supply systems, the turbine-generator units, the condensers and the cooling towers;
- vendor estimating quotations for the nuclear power plant containment liners and major nuclear and coal-fired power plant equipment; and
- apparatus handbook prices for electrical equipment.

Unit costs were obtained for structural (e.g., concrete, formwork, structural steel) and piping commodities utilizing national indices, United Engineers' power plant experience and data from field inquiries. Labor rates were updated by craft to January 1, 1983, from national indices and United Engineers' construction experience. Equipment costs that were not updated by estimating quotation or apparatus handbook were escalated to January 1, 1983 by standard percentages, based on United Engineers' experience and national indices.

5.2 CAPITAL COST SUMMARY

Capital costs were prepared for the EEDB as base construction costs, which equal the direct plus indirect costs. EEDB base construction costs include only those cost elements described in the EEDB Program Reference Book. They specifically exclude owner's costs, contingencies, escalation and allowance for funds used during construction. Direct, indirect and base construction costs are summarized in Section 2 in Tables 2-3, 2-4 and 2-5.

5.3 DETAILED CAPITAL COSTS

Results of the Capital Cost Phase VI Update are presented for each technical plant model at the two-digit and three-digit code-of-accounts level of detail in Tables 5-1 through 5-5 as indicated below. The first sheet of each table is a cost and manhours tabulation at the two-digit code-of-accounts (plant account) level of detail. The following four sheets comprise the cost and manhours tabulation at the three-digit code-of-accounts (structure/system account) level of detail. Additional detail for the PWR, BWR, LMFBR, HS8 and HS5 to the nine-digit code-of-accounts (commodity/component account) level of detail, is available in the EEDB Backup Data File.

Nuclear Plant Models	Table Number	Fossil Plant Models	Table Number
PWR	5-1	HS8	5-4
BWR	5-2	HS5	5-5
LMFBR	5-3		

5.4 CAPITAL COST CHANGES

The Phase VI Update capital costs incorporate the changes discussed in Section 4, including the commodity/equipment changes summarized in Tables 4-1 and 4-2. As previously discussed, these changes were made to meet the primary objective of the Phase VI Update, which was to refine the EEDB technical/cost data models to reflect current experience. Since the PWR and HS8 are the base EEDB power plant models, the following paragraphs will focus on their Phase V to Phase VI cost changes. As was shown in Section 3, the cost increases to the PWR are much greater than those for the HS8, particularly in the area of the indirect costs. The changes made to the PWR are representative of and the basis for the changes that occurred in the BWR and LMFBR. Likewise, the changes made to the HS8 are representative of and the basis for those that occurred in the HS5.

As was discussed in Section 4.3.1, "Review of Impact of Changing Regulations, Codes and Standards," none of the regulatory changes that have occurred between January 1, 1982 and January 1, 1983 required specific changes to be made to the quantities of commodities and equipment in the technical data models. However, the various field surveys, conducted by United during the last several years, indicate that past regulatory changes are having a continuing impact on the increase of the quantities of craft, engineering and field supervision manhours. The mechanism by which this impact occurs was discussed at length in the Phase V Update (1982) Report and was summarized in its Executive Summary (refer to Appendix C). The quantities of these manhours have been adjusted for the Phase VI Update to reflect the survey findings.

5.4.1 Presentation of the Cost Changes

Tables 5-6 and 5-7 present the capital cost changes that have occurred in the PWR and HS8, between the Phase V (1982) and Phase VI Updates. The Phase V Update costs in these tables were increased by a uniform factor of six percent, in order to remove the effects of inflation from the comparison. The tables present the base construction costs for the Phase V and Phase VI Updates in 1983 constant dollars, the differences between these costs, and the differences stated as a percentage of the inflated Phase V costs. In these tables, the direct costs are regrouped from the building/systems orientation of Tables 5-1 through 5-5, to a commodity/equipment orientation for structural, mechanical and electrical items.

The structural direct costs are the installed costs for structural commodities for the buildings in Structures and Improvements (Account 21) and in the Main Condenser Heat Rejection System (Account 26) plus the installed costs for equipment foundations and underground encasements for all other accounts. The mechanical direct costs are the installed costs for the building service equipment in Account 21 and for all of the equipment and piping in Accounts 22 through 26. The electrical/ instrumentation and control (I&C) direct costs are the installed costs for the lighting and service power systems in Account 21, the I&C equipment in Accounts 21 through 26, all of Account 24 (including the diesel-generator units), and the electric and communication equipment in Account 25.

For the indirect costs, construction services include temporary construction facilities, construction tools and equipment, and insurance, taxes and permits. Home office engineering and services include engineering services, home office quality assurance (QA) services (for nuclear power plants only), and home office construction management services. Engineering services include engineering management, engineering and design, planning and scheduling, cost engineering, and purchasing and expediting. Field office engineering and services includes field office expenses, field job supervision, field office quality assurance/quality control (QA/QC) services and startup and testing services.

5.4.2 Nuclear Power Plant Cost Changes

PWR base construction costs have increased from the Phase V to Phase VI Update at a rate that was 28 percent above inflation. Table 5-6 shows that this large increase was primarily caused by the indirect costs which have increased at a rate that is almost 11 times that of inflation, while the direct costs have increased at a rate that is only four percent higher than inflation.

5.4.2.1 Direct Costs

In the direct costs, the nuclear steam supply system (NSSS), turbine-generator unit (T/G), and structural and electrical/I&C costs have each increased at a rate that is equal to or lower than inflation. The NSSS and T/G costs were quotations from manufacturers and reflected both the depressed state of the economy (on January 1, 1983) and of the nuclear power industry. The T/G quotation was nearly the same as in 1982.

The structural costs increased at about the same rate as would be predicted from the inflation rate, even though a variety of small technical changes resulted from the structural review discussed in Sections 4.3.2 and 4.4.1. Appendix B gives details concerning these changes which occurred in the quantities of commodities and manhours. Many of the manhour increases recommended by the structural review impacted the structure building services (e.g., heating, ventilating and air conditioning and various piping systems) and consequently contributed to the cost increase in the mechanical equipment area. A few of the manhour per unit of commodity installation rates were decreased, based on experience and the various field inquiries mentioned above.

The total electrical/I&C costs have decreased over those for the Phase V Update, while cable and raceway quantities have increased, as discussed in Section 4.4.1. This has occurred because, over a period of several updates since the last detailed review of the electrical accounts, the manhours have become overstated relative to current experience. This situation was corrected by the electrical review discussed in Section 4.3.2.

The mechanical direct costs, on the other hand, have increased at a rate that was 21 percent above the rate of inflation. These increases were driven by increases in carbon and stainless steel piping commodity and unit manhours that were developed from the piping review discussed in Section 4.3.2. The piping costs increased at a rate that was more than 70 percent higher than the inflation rate.

5.4.2.2 Indirect Costs

A detailed review of the indirect costs was made in the Phase VI Update because the perception was gained from the field inquiries, that significant increases were occurring in quantities of manhours. The review also revealed that significant increases had occurred in construction services. Since a comprehensive review of the indirect costs had not been done since the data base was assembled in 1978 and since such large changes were occurring, the EEDB indirect costs were no longer representative of current experience.

The results of the comprehensive review generated large cost increases in the three two-digit indirect cost accounts. In order to explain the changes adequately, they are discussed below at the three-digit code-of-accounts level of detail. The dollar increases over those of the Phase V Update given in these discussions have been corrected for inflation.

ACCOUNT 911 - Temporary Construction Facilities

The labor associated with this account increased by 133 percent to almost 7×10^6 manhours. The most significant increases are in the 911.11 account for temporary shops, warehouses, and offices (280,000 MH), the 911.13 account for security (1,050,000 MH), the 911.21 account for roads, parking, and laydown area (1,120,000 MH), the 911.22 account for temporary electrical work (140,000 MH), the 911.24 account for temporary heat (350,000 MH), and the 911.26 account for general clean-up (600,000 MH). Additionally, a new account

911.28 was added for weather protection (600,000 MH). The total cost increase for labor and materials associated with this account equals about \$91 x 10^6, which is 22 percent of the total indirect cost increase.

ACCOUNT 912 - Construction Tools and Equipment

The \$19 x 10^6 increase in this account was primarily in the purchase cost for major equipment (912.11), for fuels and lubricants (912.14), and for expendable supplies (912.4). A new account (912.5) was added for safety equipment and inspection with a total cost of about \$1.6 x 10^6. This increase accounts for about five percent of the total increase in indirect costs.

ACCOUNT 913 - Payroll Insurance and Taxes

The \$21 x 10^6 increase in this account reflects the increased cost of direct and indirect labor. The 25 percent increase in manhours and the 11 percent increase in the average hourly labor rate combine to give the 37 percent increase in this account. This increase accounts for five percent of the total increase in the indirect costs.

ACCOUNT 921 - Home Office Services

The \$50 x 10^6 increase in this account resulted from an increase in engineering and support services of 36 percent. This account contributes about 12 percent of the total increase in indirect costs.

ACCOUNT 932 - Field Job Supervision

The \$193 x 10^6 increase in this account resulted from an increase in the manhours for job supervision of almost 300 percent. This sharp increase reflects the greater number of direct plus indirect labor manhours and the inclusion of some subcontractors' non-manual supervision. A new subaccount (932.7) was added for "manual survey engineers." This subaccount of 600,000 MH is for the unionized surveying team members (e.g., rodmen and chainmen) and are, therefore, included as site labor rather than as salaried personnel. The 932 account contributes about 47 percent of the total increase in indirect costs.

ACCOUNT 933 - Field QA/QC

The \$16 x 10^6 increase in this account resulted from an increase in the manhours for QA/QC salary personnel of over 150 percent and a new subaccount (933.5) to cover 350,000 craft manhours spent in construction training meetings. This increase contributes four percent to the increase in total indirect costs.

5.4.3 Comparison Power Plant Cost Changes

HS8 base construction costs have increased at a rate that was slower than the general rate of inflation from the Phase V to the Phase VI Updates as shown in Table 5-7.

5.4.3.1 Direct Costs

The direct costs have nearly kept pace with inflation. The fossil steam supply system, turbine-generator unit and flue gas desulfurization system costs have changed at a rate that is equal to, several points less than, and one point more than inflation respectively. This situation reflects the general state of the economy at the beginning of 1983.

Structural costs have not kept pace with inflation because of the commodity quantity reductions which are mentioned in Section 4.3.2 and which were related to the fuel handling system reconfiguration discussed in Section 4.4.2. The changes to the fuel handling system essentially transferred the costs for the old structure intensive system from the structural accounts to the mechanical accounts for the new machinery intensive system. In particular the adjustments made to structural concrete, formwork and reinforcing steel quantities have offset increases in unit costs of all structural commodities and increases in labor rates caused by inflation. The net cost result was a small decrease in real costs.

Mechanical equipment costs have increased at a rate that is higher than that which would be predicted from the inflation rate. The cost reducing effect of the piping adjustment mentioned in Section 4.3.2 is nullified by the increased costs of the coal handling and waste water treatment system modification discussed in Section 4.4.2. The net cost effect was a small increase in real costs.

Electrical/I&C costs have experienced a real decrease of 13 percent even though the I&C costs kept pace with inflation. The cost reduction was caused by the adjustment in cable and raceway quantities and unit installation manhours resulting from the detailed electrical equipment review discussed in Section 4.3.2. These adjustments have nullified the increases in unit costs and labor rates caused by inflation.

5.4.3.2 Indirect Costs

The major changes in the indirect costs were caused by making wage adjustments so that the comparison plant costs may be reflective of current industry salary rates. The same kind of adjustments were made to the nuclear power plants but the same effects are not evident, because they are masked by the large increases described in Section 5.4.2.2.

Effective Date 1/1/83

TABLE 5-1

ENERGY ECONOMIC DATA BASE - PHASE VI UPDATE

1139 MWe PRESSURIZED WATER REACTOR NPGS

CAPITAL COST ESTIMATE

PLANT CODE 148 | COST BASIS 01/83

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

06/22/84

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
21 .	STRUCTURES + IMPROVEMENTS	10,943,477	9063311 MH	167,658,008	86,931,496	265,532,981
22 .	REACTOR PLANT EQUIPMENT	199,412,349	4059370 MH	82,058,379	17,889,132	299,359,860
23 .	TURBINE PLANT EQUIPMENT	161,221,837	3089762 MH	62,061,719	10,818,296	234,101,852
24 .	ELECTRIC PLANT EQUIPMENT	28,876,413	2619599 MH	51,825,535	17,067,562	97,769,510
25 .	MISCELLANEOUS PLANT EQUIPT	17,303,003	1562223 MH	31,458,700	5,966,012	54,727,715
26 .	MAIN COND HEAT REJECT SYS	21,966,074	981040 MH	18,861,678	3,652,860	44,480,612
	TOTAL DIRECT COSTS	439,723,153	21375305 MH	413,924,019	142,325,358	995,972,530
91 .	CONSTRUCTION SERVICES	96,000,000	7415000 MH	143,400,000	93,700,000	333,100,000
92 .	HOME OFFICE ENGRG.&SERVICE	325,250,000				325,250,000
93 .	FIELD OFFICE ENGRG&SERVICE	328,300,000	1012000 MH	17,680,000	15,700,000	361,680,000
	TOTAL INDIRECT COSTS	749,550,000	8427000 MH	161,080,000	109,400,000	1,020,030,000
	TOTAL BASE COST	1,189,273,153	29802305 MH	575,004,019	251,725,358	2,016,002,530

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
211.	YARDWORK	358,366	1008092 MH	17,001,262	10,561,463	27,921,091
212.	REACTOR CONTAINMENT BLDG	2,841,174	3106289 MH	57,948,001	28,702,534	89,491,709
213.	TURBINE ROOM + HEATER BAY	536,285	887696 MH	16,875,251	14,595,715	32,007,251
214.	SECURITY BUILDING	75,000	52788 MH	1,002,638	487,912	1,565,550
215.	PRIM AUX BLDG + TUNNELS	2,952,069	789050 MH	14,692,969	5,714,807	23,359,845
216.	WASTE PROCESS BUILDING	580,642	717526 MH	13,230,414	5,822,999	19,634,055
217.	FUEL STORAGE BLDG	934,564	304592 MH	5,697,378	3,650,043	10,281,985
218A.	CONTROL RM/D-G BUILDING	1,574,364	928204 MH	17,654,329	7,115,391	26,344,084
218B.	ADMINISTRATION+SERVICE BLG	869,514	261379 MH	4,938,553	2,718,606	8,526,673
218D.	FIRE PUMP HOUSE,INC FNDTNS	36,966	15469 MH	292,225	146,939	476,130
218E.	EMERGENCY FEED PUMP BLDG	21,409	126083 MH	2,336,550	883,904	3,241,863
218F.	MANWAY TUNNELS (RCA TUNLS)		47736 MH	851,286	277,528	1,128,814
218G.	ELEC. TUNNELS	5,465	1828 MH	36,592	14,919	56,976
218H.	NON-ESSEN. SWGR BLDG.	20,904	20581 MH	385,157	261,720	667,781
218J.	MN STEAM + FW PIPE ENC.	31,560	394802 MH	7,425,639	3,119,683	10,576,882
218K.	PIPE TUNNELS		17653 MH	313,248	110,616	423,864
218L.	TECHNICAL SUPPORT CENTER	60,000	19729 MH	364,145	203,615	627,760
218M.	HYDROGEN RECOMBINER STRUCT	4,102	7579 MH	138,215	65,162	207,479
218P.	CONTAIN EQ HATCH MSLE SHLD		10277 MH	187,707	51,400	239,107
218S.	HOLDING POND		9640 MH	173,763	64,435	238,198
218T.	ULTIMATE HEAT SINK STRUCT	41,093	308284 MH	5,603,492	2,076,756	7,721,341
218V.	CONTR RM EMG AIR INTK STR		11034 MH	186,194	75,349	261,543
218Z.	WASTE WATER TREATMENT BLDG		17000 MH	323,000	210,000	533,000
21 .	STRUCTURES + IMPROVEMENTS	10,943,477	9063311 MH	167,658,008	86,931,496	265,532,981

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
220A.	NUCLEAR STEAM SUPPLY(NSSS)	139,050,000				139,050,000
220B.	NSSS OPTIONS					
221.	REACTOR EQUIPMENT	770,964	184500 MH	3,700,034	3,295,381	7,766,379
222.	MAIN HEAT XFER XPORT SYS.	3,053,817	461736 MH	9,376,459	1,161,581	13,591,857
223.	SAFEGUARDS SYSTEM	7,857,712	619001 MH	12,545,725	1,733,934	22,137,371
224.	RADWASTE PROCESSING	11,077,652	468739 MH	9,486,393	1,250,645	21,814,690
225.	FUEL HANDLING + STORAGE	4,273,034	78962 MH	1,598,398	170,136	6,041,568
226.	OTHER REACTOR PLANT EQUIP	18,619,531	1628012 MH	32,986,102	6,615,452	58,221,085
227.	RX INSTRUMENTATION+CONTROL	12,377,046	377700 MH	7,472,968	565,178	20,415,192
228.	REACTOR PLANT MISC ITEMS	2,332,593	240720 MH	4,892,300	3,096,825	10,321,718
22 .	REACTOR PLANT EQUIPMENT	199,412,349	4059370 MH	82,058,379	17,889,132	299,359,860

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
231.	TURBINE GENERATOR	110,132,487	454270 MH	9,000,548	1,657,983	120,791,018
233.	CONDENSING SYSTEMS	20,549,964	621181 MH	12,529,748	2,033,281	35,112,993
234.	FEED HEATING SYSTEM	15,794,659	579940 MH	11,755,730	1,172,108	28,722,497
235.	OTHER TURBINE PLANT EQUIP.	13,011,569	949971 MH	19,245,437	2,233,243	34,490,249
236.	INSTRUMENTATION + CONTROL	1,733,158	230900 MH	4,565,102	389,881	6,688,141
237.	TURBINE PLANT MISC ITEMS		253500 MH	4,965,154	3,331,800	8,296,954
23 .	TURBINE PLANT EQUIPMENT	161,221,837	3089762 MH	62,061,719	10,818,296	234,101,852
241.	SWITCHGEAR	10,033,856	25880 MH	510,894	78,326	10,623,076
242.	STATION SERVICE EQUIPMENT	15,786,132	128036 MH	2,525,725	347,067	18,658,924
243.	SWITCHBOARDS	1,382,728	16340 MH	322,860	123,632	1,829,220
244.	PROTECTIVE EQUIPMENT		132050 MH	2,625,100	1,648,138	4,273,238
245.	ELECT.STRUC +WIRING CONTNR		1435863 MH	28,318,482	4,936,615	33,255,097
246.	POWER & CONTROL WIRING	1,673,697	881430 MH	17,522,474	9,933,784	29,129,955
24 .	ELECTRIC PLANT EQUIPMENT	28,876,413	2619599 MH	51,825,535	17,067,562	97,769,510

PLANT CODE 148 | COST BASIS 01/83

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

06/22/84

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
251.	TRANSPORTATION & LIFT EQPT	3,003,980	58550 MH	1,187,324	475,539	4,666,843
252.	AIR,WATER+STEAM SERVICE SY	8,658,335	1202063 MH	24,353,632	4,843,273	37,855,240
253.	COMMUNICATIONS EQUIPMENT	1,948,800	192200 MH	3,820,858	585,348	6,355,006
254.	FURNISHINGS + FIXTURES	2,081,888	27410 MH	538,886	61,852	2,682,626
255.	WASTE WATER TREATMENT EQ	1,610,000	82000 MH	1,558,000		3,168,000
25 .	MISCELLANEOUS PLANT EQUIPT	17,303,003	1562223 MH	31,458,700	5,966,012	54,727,715
261.	STRUCTURES	258,105	144576 MH	2,650,503	1,372,577	4,281,185
262.	MECHANICAL EQUIPMENT	21,707,969	836464 MH	16,211,175	2,280,283	40,199,427
26 .	MAIN COND HEAT REJECT SYS	21,966,074	981040 MH	18,861,678	3,652,860	44,480,612
	TOTAL DIRECT COSTS	439,723,153	21375305 MH	413,924,019	142,325,358	995,972,530

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
911.	TEMPORARY CONSTRUCTION FAC		6990000 MH	135,200,000	28,800,000	164,000,000
912.	CONSTRUCTION TOOLS & EQUIP		425000 MH	8,200,000	62,900,000	71,100,000
913.	PAYROLL INSURANCE & TAXES	96,000,000				96,000,000
914.	PERMITS,INS. & LOCAL TAXES				2,000,000	2,000,000
915.	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	96,000,000	7415000 MH	143,400,000	93,700,000	333,100,000
921.	HOME OFFICE SERVICES	310,000,000				310,000,000
922.	HOME OFFICE Q/A	10,400,000				10,400,000
923.	HOME OFFICE CONSTRCTN MGMT	4,850,000				4,850,000
92 .	HOME OFFICE ENGRG &SERVICE	325,250,000				325,250,000
931.	FIELD OFFICE EXPENSES		62000 MH	1,180,000	15,700,000	16,880,000
932.	FIELD JOB SUPERVISION	293,550,000	600000 MH	10,600,000		304,150,000
933.	FIELD QA/QC	19,250,000	350000 MH	5,900,000		25,150,000
934.	PLANT STARTUP & TEST	15,500,000				15,500,000
93 .	FIELD OFFICE ENGRG&SERVICE	328,300,000	1012000 MH	17,680,000	15,700,000	361,680,000
	TOTAL INDIRECT COSTS	749,550,000	8427000 MH	161,080,000	109,400,000	1,020,030,000
	TOTAL BASE COST	1,189,273,153	29802305 MH	575,004,019	251,725,358	2,016,002,530

Effective Date 1/1/83

TABLE 5-2

ENERGY ECONOMIC DATA BASE - PHASE VI UPDATE

1190 MWe BOILING WATER REACTOR NPGS

CAPITAL COST ESTIMATE

PLANT CODE 201 | COST BASIS 01/83

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

06/26/84

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
21 .	STRUCTURES & IMPROVEMENTS	8,898,887	10626677 MH	196,167,523	104,918,422	309,984,832
22 .	REACTOR PLANT EQUIPMENT	179,616,162	3792568 MH	76,588,443	15,481,582	271,686,187
23 .	TURBINE PLANT EQUIPMENT	166,544,990	3178456 MH	63,845,322	11,182,664	241,572,976
24 .	ELECTRIC PLANT EQUIPMENT	30,534,521	2684101 MH	53,108,048	17,401,675	101,044,244
25 .	MISCELLANEOUS PLANT EQUIPT	16,577,376	1582754 MH	31,874,925	5,888,380	54,340,681
26 .	MAIN COND HEAT REJECT SYS	22,412,782	995984 MH	19,161,534	3,717,905	45,292,221
	TOTAL DIRECT COSTS	424,584,718	22860540 MH	440,745,795	158,590,628	1,023,921,141
91 .	CONSTRUCTION SERVICES	100,000,000	7431000 MH	143,700,000	95,740,000	339,440,000
92 .	HOME OFFICE ENGRG.&SERVICE	325,250,000				325,250,000
93 .	FIELD OFFICE ENGRG&SERVICE	342,600,000	1041000 MH	18,180,000	15,700,000	376,480,000
	TOTAL INDIRECT COSTS	767,850,000	8472000 MH	161,880,000	111,440,000	1,041,170,000
	TOTAL BASE COST	1,192,434,718	31332540 MH	602,625,795	270,030,628	2,065,091,141

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
211	YARDWORK	358,366	1010250 MH	17,040,663	10,635,264	28,034,293
212	REACTOR CONTAINMENT BLDG	1,907,096	3607853 MH	67,090,437	37,618,432	106,615,965
213	TURBINE ROOM + HEATER BAY	1,854,039	2020526 MH	37,548,903	23,305,296	62,708,238
214	SECURITY BUILDING	75,000	52788 MH	1,002,638	487,912	1,565,550
215	AUXILIARY BLDG + TUNNELS	429,652	1128001 MH	20,997,052	8,718,799	30,145,503
216	WASTE PROCESS BUILDING	508,154	576053 MH	10,661,531	4,851,096	16,020,781
217	FUEL STORAGE BLDG	1,006,620	443624 MH	8,221,749	5,011,277	14,239,646
218A	CONTROL RM/D-G BUILDING	1,750,761	1086035 MH	20,655,101	8,342,017	30,747,879
218B	ADMINISTRATION+SERVICE BLG	871,140	261419 MH	4,939,463	2,718,697	8,529,300
218D	FIRE PUMP HOUSE,INC FNDTNS	36,966	15469 MH	292,225	146,939	476,130
218K	PIPE TUNNELS		48083 MH	861,265	358,133	1,219,398
218L	TECHNICAL SUPPORT CENTER	60,000	19729 MH	364,145	203,615	627,760
218S	HOLDING POND		9640 MH	173,763	64,435	238,198
218T	ULTIMATE HEAT SINK STRUCT	41,093	319173 MH	5,809,394	2,171,161	8,021,648
218V	CONTR RM EMG AIR INTK STR		11034 MH	186,194	75,349	261,543
218Z	WASTE WATER TREATMENT BLDG		17000 MH	323,000	210,000	533,000
21	STRUCTURES & IMPROVEMENTS	8,898,887	10626677 MH	196,167,523	104,918,422	309,984,832

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
220A.	NUCLEAR STEAM SUPPLY(NSSS)	130,800,000				130,800,000
220B.	NSSS OPTIONS					
221.	REACTOR EQUIPMENT	839,199	977100 MH	19,705,449	4,726,183	25,270,831
222.	MAIN HEAT XFER XPORT SYS.	616,376	183133 MH	3,729,024	369,343	4,714,743
223.	SAFEGUARDS SYSTEM	9,234,361	525262 MH	10,652,744	1,056,254	20,943,359
224.	RADWASTE PROCESSING	13,829,919	458468 MH	9,279,431	2,058,902	25,168,252
225.	FUEL HANDLING + STORAGE	2,059,374	76934 MH	1,558,504	163,136	3,781,014
226.	OTHER REACTOR EQUIP.	9,646,891	907071 MH	18,381,037	3,630,808	31,658,736
227.	INSTRUMENTATION + CONTROL	12,590,042	421800 MH	8,344,860	595,824	21,530,726
228.	REACTOR PLANT MISC ITEMS		242800 MH	4,937,394	2,881,132	7,818,526
22 .	REACTOR PLANT EQUIPMENT	179,616,162	3792568 MH	76,588,443	15,481,582	271,686,187
231.	TURBINE GENERATOR	111,933,975	484089 MH	9,606,434	1,730,409	123,270,818
233.	CONDENSING SYSTEMS	21,507,634	661647 MH	13,348,815	2,114,437	36,970,886
234.	FEED HEATING SYSTEM	15,289,143	569979 MH	11,552,352	1,151,726	27,993,221
235.	OTHER TURBINE PLANT EQUIP.	16,118,205	951561 MH	19,276,703	2,236,131	37,631,039
236.	INSTRUMENTATION + CONTROL	1,696,033	257000 MH	5,081,122	442,868	7,220,023
237.	TURBINE PLANT MISC ITEMS		254180 MH	4,979,896	3,507,093	8,486,989
23 .	TURBINE PLANT EQUIPMENT	166,544,990	3178456 MH	63,845,322	11,182,664	241,572,976

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
241.	SWITCHGEAR	9,796,731	28135 MH	555,412	82,122	10,434,265
242.	STATION SERVICE EQUIPMENT	17,749,213	159808 MH	3,166,860	423,825	21,339,898
243.	SWITCHBOARDS	1,382,728	16340 MH	322,860	123,575	1,829,163
244.	PROTECTIVE EQUIPMENT		132050 MH	2,625,100	1,648,138	4,273,238
245.	ELECT.STRUC +WIRING CONTNR		1463353 MH	28,855,999	5,034,692	33,890,691
246.	POWER & CONTROL WIRING	1,605,849	884415 MH	17,581,817	10,089,323	29,276,989
24 .	ELECTRIC PLANT EQUIPMENT	30,534,521	2684101 MH	53,108,048	17,401,675	101,044,244
251.	TRANSPORTATION & LIFT EQPT	2,244,683	59400 MH	1,204,562	519,759	3,969,004
252.	AIR,WATER+STEAM SERVICE SY	8,692,005	1221744 MH	24,752,619	4,721,421	38,166,045
253.	COMMUNICATIONS EQUIPMENT	1,948,800	192200 MH	3,820,858	585,348	6,355,006
254.	FURNISHINGS + FIXTURES	2,081,888	27410 MH	538,886	61,852	2,682,626
255.	WASTE WATER TREATMENT EQ	1,610,000	82000 MH	1,558,000		3,168,000
25 .	MISCELLANEOUS PLANT EQUIPT	16,577,376	1582754 MH	31,874,925	5,888,380	54,340,681
261.	STRUCTURES	258,105	146059 MH	2,678,540	1,394,879	4,331,524
262.	MECHANICAL EQUIPMENT	22,154,677	849925 MH	16,482,994	2,323,026	40,960,697
26 .	MAIN COND HEAT REJECT SYS	22,412,782	995984 MH	19,161,534	3,717,905	45,292,221
	TOTAL DIRECT COSTS	424,584,718	22860540 MH	440,745,795	158,590,628	1,023,921,141

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
911.	TEMPORARY CONSTRUCTION FAC		6997000 MH	135,300,000	28,900,000	164,200,000
912.	CONSTRUCTION TOOLS & EQUIP		434000 MH	8,400,000	64,800,000	73,200,000
913.	PAYROLL INSURANCE & TAXES	100,000,000				100,000,000
914.	PERMITS,INS & LOCAL TAXES				2,040,000	2,040,000
915.	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	100,000,000	7431000 MH	143,700,000	95,740,000	339,440,000
921.	HOME OFFICE SERVICES	310,000,000				310,000,000
922.	HOME OFFICE Q/A	10,400,000				10,400,000
923.	HOME OFFICE CONSTRCTN MGMT	4,850,000				4,850,000
92 .	HOME OFFICE ENGRG.&SERVICE	325,250,000				325,250,000
931.	FIELD OFFICE EXPENSES		62000 MH	1,180,000	15,700,000	16,880,000
932.	FIELD JOB SUPERVISION	307,050,000	609000 MH	10,800,000		317,850,000
933.	FIELD QA/QC	20,050,000	370000 MH	6,200,000		26,250,000
934.	PLANT STARTUP & TEST	15,500,000				15,500,000
93 .	FIELD OFFICE ENGRG&SERVICE	342,600,000	1041000 MH	18,180,000	15,700,000	376,480,000
	TOTAL INDIRECT COSTS	767,850,000	8472000 MH	161,880,000	111,440,000	1,041,170,000
	TOTAL BASE COST	1,192,434,718	31332540 MH	602,625,795	270,030,628	2,065,091,141

Effective Date 1/1/83

TABLE 5-3

ENERGY ECONOMIC DATA BASE - PHASE VI UPDATE

1457 MWe LIQUID METAL FAST BREEDER REACTOR NPGS

CAPITAL COST ESTIMATE

PLANT CODE 401 | COST BASIS 01/83

UNITED ENGINEERS & CONSTRUCTORS INC.
ENERGY ECONOMIC DATA BASE (EEDB) PHASE VI
1457 MWE LIQUID METAL FAST BREEDER REACTOR

06/26/84

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
21 .	STRUCTURES + IMPROVEMENTS	18,336,487	13124689 MH	243,656,926	133,785,320	395,778,733
22 .	REACTOR PLANT EQUIPMENT	464,825,042	7077000 MH	143,006,070	23,708,310	631,539,422
23 .	TURBINE PLANT EQUIPMENT	187,119,051	3525401 MH	70,761,640	11,501,124	269,381,815
24 .	ELECTRIC PLANT EQUIPMENT	31,464,099	3818656 MH	75,341,945	24,406,565	131,212,609
25 .	MISCELLANEOUS PLANT EQUIPT	28,513,731	2129375 MH	42,831,492	6,466,291	77,811,514
26 .	MAIN COND HEAT REJECT SYS	22,412,665	997897 MH	19,201,037	3,721,765	45,335,467
	TOTAL DIRECT COSTS	752,671,075	30673018 MH	594,799,110	203,589,375	1,551,059,560
91 .	CONSTRUCTION SERVICES	131,900,000	8711000 MH	168,180,000	130,180,000	430,260,000
92 .	HOME OFFICE ENGRG.&SERVICE	442,700,000				442,700,000
93 .	FIELD OFFICE ENGRG&SERVICE	447,000,000	1487000 MH	25,940,000	17,600,000	490,540,000
	TOTAL INDIRECT COSTS	1,021,600,000	10198000 MH	194,120,000	147,780,000	1,363,500,000
	TOTAL BASE COST	1,774,271,075	40871018 MH	788,919,110	351,369,375	2,914,559,560

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
211	YARDWORK	427,366	1371826 MH	23,077,956	13,667,160	37,172,482
212	REACTOR CONTAINMENT BLDG	8,034,551	5703853 MH	107,034,814	58,418,058	173,487,423
213	TURBINE ROOM + HEATER BAY	577,563	901939 MH	17,181,130	15,357,866	33,116,559
214	SECURITY + TSC BUILDING	150,000	87751 MH	1,657,857	781,293	2,589,150
215.	REACTOR SERVICE BUILDING	3,327,137	1261194 MH	23,571,849	9 923,995	36,822,981
216	WASTE PROCESS BUILDING					
217.	FUEL STORAGE BLDG					
218A	CONTROL RM/D-G BUILDING	2,533,686	1169746 MH	22,325,900	9,112,518	33,972,104
218B	ADMINISTRATION BUILDING	221,007	97523 MH	1,855,998	1,209,599	3,286,604
218C	D/G COOLING TOWER		77693 MH	1,412,808	606,767	2,019,575
218D	FIRE PUMP HOUSE,INC FNDTNS	36,966	15469 MH	292,225	146,939	476,130
218E.	STEAM GENERATOR BUILDING	968,376	847468 MH	15,824,859	9,586,091	26,379,326
218H.	NON-ESSEN SWGR BLDG	23,469	31100 MH	584,454	395,126	1,003,049
218I.	AUXILIARY BUILDINGS	733,532	740838 MH	13,632,869	6,617,569	20,983,970
218K	PIPE TUNNELS		18115 MH	320,697	110,616	431,313
218N	MAINTENANCE BUILDING	731,692	190623 MH	3,619,510	2,171,307	6,522,509
218R	AUXILIARY BOILER BUILDING	178,982	56096 MH	1,060,674	733,163	1,972,819
218S	HOLDING POND		9640 MH	173,763	64,435	238,198
218T	ULTIMATE HEAT SINK STRUCT	117,499	165415 MH	3,007,284	1,017,994	4,142,777
218V	CONTR RM EMG AIR INTK STR		11034 MH	186,194	75,349	261,543
218W	AUX HEAT TRANS SYS BAYS	274,661	350366 MH	6,513,085	3,579,475	10,367,221
218Z	WASTE WATER TREATMENT BLDG		17000 MH	323,000	210,000	533,000
21	STRUCTURES + IMPROVEMENTS	18,336 487	13124689 MH	243,656,926	133,785,320	395,778,733

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
220A.	NUCLEAR STEAM SUPPLY(NSSS)	431,000,000				431,000,000
220B.	NSSS OPTIONS					
221.	REACTOR EQUIPMENT	152,250	488120 MH	9,769,223	5,786,309	15,707,782
222.	MAIN HEAT XFER XPORT SYS.	5,969,178	3819738 MH	77,399,656	7,690,539	91,059,373
223.	SAFEGUARDS SYSTEM	39,141	178867 MH	3,623,287	362,330	4,024,758
224.	RADWASTE PROCESSING	10,098,950	447870 MH	9,054,426	1,033,902	20,187,278
225.	FUEL HANDLING	175,070	339187 MH	6,856,398	659,507	7,690,975
226.	OTHER REACTOR PLANT EQUIP	7,998,448	926818 MH	18,629,634	2,270,357	28,898,439
227.	RX INSTRUMENTATION+CONTROL	6,359,635	518400 MH	10,285,206	852,928	17,497,769
228.	REACTOR PLANT MISC ITEMS	3,032,370	358000 MH	7,388,240	5,052,438	15,473,048
22 .	REACTOR PLANT EQUIPMENT	464,825,042	7077000 MH	143,006,070	23,708,310	631,539,422
231.	TURBINE GENERATOR	124,162,233	558863 MH	11,070,243	2,090,517	137,322,993
233.	CONDENSING SYSTEMS	27,017,348	950652 MH	19,188,003	2,273,048	48,478,399
234.	FEED HEATING SYSTEM	19,085,923	522409 MH	10,595,806	1,053,844	30,735,573
235.	OTHER TURBINE PLANT EQUIP.	15,131,122	988797 MH	20,037,712	2,130,708	37,299,542
236.	INSTRUMENTATION + CONTROL	1,722,425	230900 MH	4,565,102	398,103	6,685,630
237.	TURBINE PLANT MISC ITEMS		273780 MH	5,304,774	3,554,904	8,859,678
23 .	TURBINE PLANT EQUIPMENT	187,119,051	3525401 MH	70,761,640	11,501,124	269,381,815

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
241.	SWITCHGEAR	11,615,171	36240 MH	715,412	98,757	12,429,340
242.	STATION SERVICE EQUIPMENT	16,551,913	135430 MH	2,665,881	380,450	19,598,244
243.	SWITCHBOARDS	1,413,668	16340 MH	322,860	128,654	1,865,182
244.	PROTECTIVE EQUIPMENT		132550 MH	2,635,041	1,709,600	4,344,641
245.	ELECT.STRUC +WIRING CONTNR		2275851 MH	44,705,010	8,058,342	52,763,352
246.	POWER & CONTROL WIRING	1,883,347	1222245 MH	24,297,741	14,030,762	40,211,850
24 .	ELECTRIC PLANT EQUIPMENT	31,464,099	3818656 MH	75,341,945	24,406,565	131,212,609
251.	TRANSPORTATION & LIFT EQPT	4,838,500	72050 MH	1,461,088	102,915	6,402,503
252.	AIR,WATER+STEAM SERVICE SY	16,918,234	1685785 MH	34,062,888	5,574,900	56,556,022
253.	COMMUNICATIONS EQUIPMENT	2,855,422	261200 MH	5,192,551	722,517	8,770,490
254.	FURNISHINGS + FIXTURES	2,291,575	28340 MH	556,965	65,959	2,914,499
255.	WASTE WATER TREATMENT EQ	1,610,000	82000 MH	1,558,000		3,168,000
25 .	MISCELLANEOUS PLANT EQUIPT	28,513,731	2129375 MH	42,831,492	6,466,291	77,811,514
261.	STRUCTURES	258,105	146077 MH	2,679,613	1,394,897	4,332,615
262.	MECHANICAL EQUIPMENT	22,154,560	851820 MH	16,521,424	2,326,868	41,002,852
26 .	MAIN COND HEAT REJECT SYS	22,412,665	997897 MH	19,201,037	3,721,765	45,335,467
	TOTAL DIRECT COSTS	752,671,075	30673018 MH	594,799,110	203,589,375	1,551,059,560

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
911.	TEMPORARY CONSTRUCTION FAC		8062000 MH	155,600,000	33,900,000	189,500,000
912.	CONSTRUCTION TOOLS & EQUIP		649000 MH	12,580,000	93,380,000	105,960,000
913.	PAYROLL INSURANCE & TAXES	131,900,000				131,900,000
914.	PERMITS,INS. & LOCAL TAXES				2,900,000	2,900,000
915	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	131,900,000	8711000 MH	168,180,000	130,180,000	430,260,000
921.	HOME OFFICE SERVICES	423,000,000				423,000,000
922.	HOME OFFICE Q/A	14,200,000				14,200,000
923.	HOME OFFICE CONSTRCTN MGMT	5,500,000				5,500,000
92 .	HOME OFFICE ENGRG &SERVICE	442,700,000				442,700,000
931.	FIELD OFFICE EXPENSES		70000 MH	1,340,000	17,600,000	18,940,000
932.	FIELD JOB SUPERVISION	403,100,000	937000 MH	16,500,000		419,600,000
933.	FIELD QA/QC	26,400,000	480000 MH	8,100,000		34,500,000
934.	PLANT STARTUP & TEST	17,500,000				17,500,000
93 .	FIELD OFFICE ENGRG&SERVICE	447,000,000	1487000 MH	25,940,000	17,600,000	490,540,000
	TOTAL INDIRECT COSTS	1,021,600,000	10198000 MH	194,120,000	147,780,000	1,363,500,000
	TOTAL BASE COST	1,774,271,075	40871018 MH	788,919,110	351,369,375	2,914,559,560

Effective Date 1/1/83

TABLE 5-4

ENERGY ECONOMIC DATA BASE - PHASE VI UPDATE

791 MWe HIGH SULFUR COAL FPGS

CAPITAL COST ESTIMATE

PLANT CODE 645 COST BASIS 01/83

UNITED ENGINEERS & CONSTRUCTORS INC
ENERGY ECONOMIC DATA BASE (EEDB) PHASE VI
791 MWE HIGH SULFUR COAL

06/26/84

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
21 .	STRUCTURES + IMPROVEMENTS	2,499,061	1538313 MH	27,933,367	40,379,434	70,811,862
22 .	BOILER PLANT EQUIPMENT	178,611,371	3051492 MH	61,555,990	24,460,344	264,627,705
23 .	TURBINE PLANT EQUIPMENT	87,054,652	991084 MH	19,786,834	4,874,558	111,716,044
24 .	ELECTRIC PLANT EQUIPMENT	15,022,172	781727 MH	15,453,299	10,502,143	40,977,614
25 .	MISCELLANEOUS PLANT EQUIPT	10,251,080	483125 MH	9,837,647	1,952,679	22,041,406
26 .	MAIN COND HEAT REJECT SYS	12,827,017	449812 MH	8,741,648	2,282,215	23,850,880
	TOTAL DIRECT COSTS	306,265,353	7295553 MH	143,308,785	84,451,373	534,025,511
91 .	CONSTRUCTION SERVICES	28,520,000	1234800 MH	23,780,000	24,930,000	77,230,000
92 .	HOME OFFICE ENGRG.&SERVICE	28,340,000				28,340,000
93 .	FIELD OFFICE ENGRG&SERVICE	21,160,000			1,810,000	22,970,000
	TOTAL INDIRECT COSTS	78,020,000	1234800 MH	23,780,000	26,740,000	128,540,000
	TOTAL BASE COST	384,285,353	8530353 MH	167,088,785	111,191,373	662,565,511

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
211.	YARDWORK	177,366	316940 MH	5,141,726	4,935,018	10,254,110
212.	STEAM GENERATOR BUILDING	890,728	448537 MH	8,488,365	14,952,729	24,331,822
213.	TURBINE,HEATER,CONTROL BLD	604,927	304960 MH	5,753,185	9,126,645	15,484,757
218B.	ADMINISTRATION+SERVICE BLD	330,582	63268 MH	1,223,331	1,281,148	2,835,061
218I.	ELECTRICAL SWITCHGR BLDGS	34,996	7032 MH	136,280	65,192	236,468
218L.	STACK/RECLAIM TRANSFR TWR	6,278	7055 MH	143,070	87,847	237,195
218M.	COAL CAR THAW SHED		2657 MH	49,958	21,016	70,974
218N.	ROTARY CAR DUMP BLDG+TUNNL	5,718	43331 MH	771,956	568,881	1,346,555
218O.	COAL BREAKER HOUSE	93,863	21417 MH	412,416	590,472	1,096,751
218P.	COAL CRUSHER HOUSE	130,999	15379 MH	298,634	312,120	741,753
218Q.	BOILER HOUSE TRANSFR TOWER	2,921	3120 MH	60,906	119,275	183,102
218R.	DEAD STORAGE TRANSFER TUN.		40745 MH	744,045	399,300	1,143,345
218T.	LOCOMOTIVE REPAIR GARAGE	18,984	5272 MH	101,561	106,294	226,839
218U.	MATERIAL HANDL+SERVICE BLD	22,536	10875 MH	207,828	221,361	451,725
218V.	WASTE WATER TREATMENT BLDG	4,863	9363 MH	166,968	122,926	294,757
218W.	MISC COAL HANDLING STRUCT	174,300	90051 MH	1,631,959	2,200,030	4,006,289
219.	STACK STRUCTURE		148311 MH	2,601,179	5,269,180	7,870,359
21 .	STRUCTURES + IMPROVEMENTS	2,499,061	1538313 MH	27,933,367	40,379,434	70,811,862

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
220A.	FOSSIL STEAM SUPPLY SYSTEM	71,380,400	736304 MH	14,946,971	1,494,697	87,822,068
221.	STEAM GENERATING SYSTEM	1,673,665	36302 MH	737,506	79,059	2,490,230
222.	DRAFT SYSTEM	10,946,561	340772 MH	6,911,881	7,148,857	25,007,299
223.	ASH + DUST HANDLING SYSTEM	4,891,973	103373 MH	2,085,731	251,725	7,229,429
224.	FUEL HANDLING SYSTEMS	17,422,673	216446 MH	4,390,007	1,002,731	22,815,411
225.	FLUE GAS DESULFUR STRUCT	2,424,857	272477 MH	5,163,705	5,228,282	12,816,844
226.	DESULFURIZATION EQUIPMENT	64,862,723	1181418 MH	24,254,226	7,542,180	96,659,129
227.	INSTRUMENTATION + CONTROL	4,714,878	81220 MH	1,605,794	110,896	6,431,568
228.	BOILER PLANT MISC ITEMS	293,641	83180 MH	1,460,169	1,601,917	3,355,727
22 .	BOILER PLANT EQUIPMENT	178,611,371	3051492 MH	61,555,990	24,460,344	264,627,705
231.	TURBINE GENERATOR	60,235,949	268584 MH	5,314,701	1,300,696	66,851,346
233.	CONDENSING SYSTEMS	7,604,539	94138 MH	1,900,968	475,131	9,980,638
234.	FEED HEATING SYSTEM	9,858,712	173975 MH	3,536,510	356,163	13,751,385
235.	OTHER TURBINE PLANT EQUIP.	9,192,804	375654 MH	7,612,565	795,231	17,600,600
236.	INSTRUMENTATION + CONTROL	162,648	823 MH	16,272	813	179,733
237.	TURBINE PLANT MISC ITEMS		77910 MH	1,405,818	1,946,524	3,352,342
23 .	TURBINE PLANT EQUIPMENT	87,054,652	991084 MH	19,786,834	4,874,558	111,716,044

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
241.	SWITCHGEAR	8,125,542	16860 MH	332,831	60,471	8,518,844
242.	STATION SERVICE EQUIPMENT	5,320,575	31685 MH	614,921	138,881	6,074,377
243.	SWITCHBOARDS	769,919	9030 MH	178,442	105,976	1,054,337
244.	PROTECTIVE EQUIPMENT		88230 MH	1,755,959	1,353,033	3,108,992
245.	ELECT.STRUC +WIRING CONTNR		430765 MH	8,492,709	2,836,274	11,328,983
246.	POWER & CONTROL WIRING	806,136	205157 MH	4,078,437	6,007,508	10,892,081
24 .	ELECTRIC PLANT EQUIPMENT	15,022,172	781727 MH	15,453,299	10,502,143	40,977,614
251.	TRANSPORTATION & LIFT EQPT	1,796,807	18200 MH	368,152	308,426	2,473,385
252.	AIR,WATER+STEAM SERVICE SY	4,665,027	244274 MH	4,949,431	962,273	10,576,731
253.	COMMUNICATIONS EQUIPMENT	215,547	53500 MH	1,063,559	291,546	1,570,652
254.	FURNISHINGS + FIXTURES	907,613	11900 MH	233,573	34,684	1,175,870
255.	WASTE WATER TREATMENT EQPT	2,666,086	155251 MH	3,222,932	355,750	6,244,768
25 .	MISCELLANEOUS PLANT EQUIPT	10,251,080	483125 MH	9,837,647	1,952,679	22,041,406
261.	STRUCTURES	208,515	80009 MH	1,473,296	1,064,155	2,745,966
262.	MECHANICAL EQUIPMENT	12,618,502	369803 MH	7,268,352	1,218,060	21,104,914
26 .	MAIN COND HEAT REJECT SYS	12,827,017	449812 MH	8,741,648	2,282,215	23,850,880
	TOTAL DIRECT COSTS	306,265,353	7295553 MH	143,308,785	84,451,373	534,025,511

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
911.	TEMPORARY CONSTRUCTION FAC		1067000 MH	20,550,000	8,330,000	28,880,000
912.	CONSTRUCTION TOOLS & EQUIP		167800 MH	3,230,000	15,920,000	19,150,000
913.	PAYROLL INSURANCE & TAXES	28,520,000				28,520,000
914.	PERMITS,INS. & LOCAL TAXES				680,000	680,000
915.	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	28,520,000	1234800 MH	23,780,000	24,930,000	77,230,000
921.	HOME OFFICE SERVICES	26,140,000				26,140,000
922.	HOME OFFICE Q/A					
923.	HOME OFFICE CONSTRCTN MGMT	2,200,000				2,200,000
92 .	HOME OFFICE ENGRG.&SERVICE	28,340,000				28,340,000
931.	FIELD OFFICE EXPENSES				1,810,000	1,810,000
932.	FIELD JOB SUPERVISION	19,835,000				19,835,000
933.	FIELD QA/QC	545,000				545,000
934.	PLANT STARTUP & TEST	780,000				780,000
93 .	FIELD OFFICE ENGRG&SERVICE	21,160,000			1,810,000	22,970,000
	TOTAL INDIRECT COSTS	78,020,000	1234800 MH	23,780,000	26,740,000	128,540,000
	TOTAL BASE COST	384,285,353	8530353 MH	167,088,785	111,191,373	662,565,511

Effective Date 1/1/83

TABLE 5-5

ENERGY ECONOMIC DATA BASE - PHASE VI UPDATE

486 MWe HIGH SULFUR COAL FPGS

CAPITAL COST ESTIMATE

PLANT CODE 669 | COST BASIS 01/83

UNITED ENGINEERS & CONSTRUCTORS INC
ENERGY ECONOMIC DATA BASE (EEDB) PHASE VI
486 MWE HIGH SULFUR COAL

06/26/84

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
21 .	STRUCTURES + IMPROVEMENTS	2,073,715	1248006 MH	22,649,091	32,579,048	57,301,854
22 .	BOILER PLANT EQUIPMENT	132,287,089	2351014 MH	47,086,368	18,609,672	197,983,129
23 .	TURBINE PLANT EQUIPMENT	61,371,723	713099 MH	14,196,081	3,879,354	79,447,158
24 .	ELECTRIC PLANT EQUIPMENT	12,796,716	677789 MH	13,399,405	8,981,578	35,177,699
25 .	MISCELLANEOUS PLANT EQUIPT	9,502,883	431029 MH	8,777,215	1,716,661	19,996,759
26 .	MAIN COND HEAT REJECT SYS	8,378,755	305359 MH	5,907,706	1,949,567	16,236,028
	TOTAL DIRECT COSTS	226,410,881	5726296 MH	112,015,866	67,715,880	406,142,627
91 .	CONSTRUCTION SERVICES	22,300,000	991100 MH	19,080,000	19,365,000	60,745,000
92 .	HOME OFFICE ENGRG &SERVICE	21,210,000				21,210,000
93 .	FIELD OFFICE ENGRG&SERVICE	16,575,000			1,490,000	18,065,000
	TOTAL INDIRECT COSTS	60,085,000	991100 MH	19,080,000	20,855,000	100,020,000
	TOTAL BASE COST	286,495,881	6717396 MH	131,095,866	88,570,880	506,162,627

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
211	YARDWORK	140,112	266925 MH	4,336,791	4,331,506	8,808,409
212	STEAM GENERATOR BUILDING	745 342	347631 MH	6,582,804	11,987,818	19,315,964
213	TURBINE,HEATER,CONTROL BLD	469 926	237904 MH	4,504,606	7,108,709	12,083,241
218B	ADMINISTRATION+SERVICE BLD	290,580	55000 MH	1,063,453	1,132,190	2,486,223
218I	ELECTRICAL SWITCHGR BLDGS	25,904	5448 MH	105,329	51,287	182,520
218L	STACK/RECLAIM TRANSFR TWR	5,606	6378 MH	118,569	78,651	202,826
218M	COAL CAR THAW SHED		2657 MH	49,958	21,016	70,974
218N	ROTARY CAR DUMP BLDG+TUNNL	5,718	43331 MH	771,956	568,880	1,346,554
218O	COAL BREAKER HOUSE	92 794	18537 MH	357,487	507,396	957,677
218P	COAL CRUSHER HOUSE	116,260	13256 MH	257,040	274,890	648,190
218Q	BOILER HOUSE TRANSFR TOWER	2,367	2507 MH	48,903	94,611	145,881
218R	DEAD STRG TRANSFER TUNNEL		35391 MH	645,982	349,196	995,178
218T.	LOCOMOTIVE REPAIR GARAGE	18,984	5272 MH	101,561	106,294	226,839
218U	MATERIAL HANDL+SERVICE BLD	22,536	10875 MH	207,296	221,361	451,193
218V	WASTE WATER TREATMENT BLDG	3 986	7516 MH	134,191	100,996	239,173
218W	MISC COAL HANDLING STRUCT	133,600	72555 MH	1,315,632	1,794,923	3,244,155
219	STACK STRUCTURE		116823 MH	2,047,533	3,849,324	5,896,857
21	STRUCTURES + IMPROVEMENTS	2 073,715	1248006 MH	22,649,091	32,579,048	57,301,854

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
220A.	FOSSIL STEAM SUPPLY SYSTEM	49,728,000	550000 MH	11,165,000	1,116,500	62,009,500
221.	STEAM GENERATING SYSTEM	1,268,903	27896 MH	566,548	61,683	1,897,134
222.	DRAFT SYSTEM	7,541,504	243609 MH	4,936,471	5,052,252	17,530,227
223.	ASH + DUST HANDLING SYSTEM	3,937,000	79393 MH	1,602,821	192,121	5,731,942
224.	FUEL HANDLING SYSTEMS	15,505,805	188417 MH	3,821,439	798,834	20,126,078
225.	FLUE GAS DESULFUR STRUCT	1,850,000	205000 MH	3,581,350	4,240,000	9,671,350
226.	DESULFURIZATION EQUIPMENT	48,047,618	911516 MH	18,688,168	5,747,161	72,482,947
227.	INSTRUMENTATION + CONTROL	4,170,916	77758 MH	1,537,353	109,154	5,817,423
228.	BOILER PLANT MISC ITEMS	237,343	67425 MH	1,187,218	1,291,967	2,716,528
22 .	BOILER PLANT EQUIPMENT	132,287,089	2351014 MH	47,086,368	18,609,672	197,983,129
231.	TURBINE GENERATOR	41,771,063	205134 MH	4,050,532	1,059,575	46,881,170
233.	CONDENSING SYSTEMS	6,061,664	79254 MH	1,600,559	396,548	8,058,771
234.	FEED HEATING SYSTEM	7,334,197	134213 MH	2,722,158	274,584	10,330,939
235.	OTHER TURBINE PLANT EQUIP	6,075,245	228362 MH	4,628,285	489,081	11,192,611
236.	INSTRUMENTATION + CONTROL	129,554	692 MH	13,668	684	143,906
237.	TURBINE PLANT MISC ITEMS		65444 MH	1,180,879	1,658,882	2,839,761
23 .	TURBINE PLANT EQUIPMENT	61,371,723	713099 MH	14,196,081	3,879,354	79,447,158

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
241.	SWITCHGEAR	6,581,481	16210 MH	319,999	58,320	6,959,800
242.	STATION SERVICE EQUIPMENT	4,848,791	28952 MH	562,084	125,555	5,536,430
243.	SWITCHBOARDS	769,919	8830 MH	174,466	93,259	1,037,644
244.	PROTECTIVE EQUIPMENT		81030 MH	1,612,827	1,264,920	2,877,747
245.	ELECT.STRUC +WIRING CONTNR		364470 MH	7,185,555	2,349,800	9,535,355
246.	POWER & CONTROL WIRING	596,525	178297 MH	3,544,474	5,089,724	9,230,723
24 .	ELECTRIC PLANT EQUIPMENT	12,796,716	677789 MH	13,399,405	8,981,578	35,177,699
251.	TRANSPORTATION & LIFT EQPT	1,746,806	15560 MH	314,615	257,128	2,318,549
252.	AIR,WATER+STEAM SERVICE SY	4,217,501	213845 MH	4,332,230	836,756	9,386,487
253.	COMMUNICATIONS EQUIPMENT	191,260	48500 MH	964,161	266,983	1,422,404
254.	FURNISHINGS + FIXTURES	846,671	11380 MH	223,505	32,086	1,102,262
255.	WASTE WATER TREATMENT EQPT	2,500,645	141744 MH	2,942,704	323,708	5,767,057
25 .	MISCELLANEOUS PLANT EQUIPT	9,502,883	431029 MH	8,777,215	1,716,661	19,996,759
261.	STRUCTURES	174,240	66132 MH	1,216,289	897,254	2,287,783
262.	MECHANICAL EQUIPMENT	8,204,515	239227 MH	4,691,417	1,052,313	13,948,245
26 .	MAIN COND HEAT REJECT SYS	8,378,755	305359 MH	5,907,706	1,949,567	16,236,028
	TOTAL DIRECT COSTS	226,410,881	5726296 MH	112,015,866	67,715,880	406,142,627

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
911.	TEMPORARY CONSTRUCTION FAC		864100 MH	16,635,000	6,640,000	23,275,000
912.	CONSTRUCTION TOOLS & EQUIP		127000 MH	2,445,000	12,205,000	14,650,000
913.	PAYROLL INSURANCE & TAXES	22,300,000				22,300,000
914.	PERMITS,INS. & LOCAL TAXES				520,000	520,000
915.	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	22,300,000	991100 MH	19,080,000	19,365,000	60,745,000
921.	HOME OFFICE SERVICES	19,420,000				19,420,000
922.	HOME OFFICE Q/A					
923.	HOME OFFICE CONSTRCTN MGMT	1,790,000				1,790,000
92 .	HOME OFFICE ENGRG.&SERVICE	21,210,000				21,210,000
931.	FIELD OFFICE EXPENSES				1,490,000	1,490,000
932.	FIELD JOB SUPERVISION	15,440,000				15,440,000
933.	FIELD QA/QC	425,000				425,000
934.	PLANT STARTUP & TEST	710,000				710,000
93 .	FIELD OFFICE ENGRG&SERVICE	16,575,000			1,490,000	18,065,000
	TOTAL INDIRECT COSTS	60,085,000	991100 MH	19,080,000	20,855,000	100,020,000
	TOTAL BASE COST	286,495,881	6717396 MH	131,095,866	88,570,880	506,162,627

TABLE 5-6

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
PHASE V TO PHASE VI UPDATE BASE CONSTRUCTION COST INCREASES FOR THE PRESSURIZED WATER REACTOR NUCLEAR POWER GENERATING STATION (PWR)

Commodity/Equipment/Service	Installed Costs ($1983 x 10^6)[a] Phase V (1982)	Phase VI (1983)	Delta	Delta as a % of Phase V
NSSS + T/G[b]	271	260	(-) 11	(-) 4
Mechanical (w/o NSSS + T/G)	277	340	63	23
Sub-Total Mechanical	548	600	52	9
Structural	257	257	0	0
Electrical/I&C	152	139	(-) 13	(-) 9
Total Direct Costs	957	996	39	4
Construction Services	201	333	132	66
Home Office Eng. and Services	276	325	49	18
Field Office Eng. and Services	135	362	227	168
Total Indirect Costs	612	1,020	408	67
TOTAL BASE CONSTRUCTION COSTS	1,569	2,016	447	28

(a) Data in Constant $1983
(b) Nuclear Steam Supply System plus Turbine-Generator Unit

TABLE 5-7

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
PHASE V TO PHASE VI UPDATE BASE CONSTRUCTION COST INCREASES FOR THE
800 MWe HIGH SULFUR COAL-FIRED POWER GENERATING STATION (HS8)

Commodity/Equipment/Service	Installed Costs ($1983 x 10^6)[a] Phase V (1982)	Phase VI (1983)	Delta	Delta as a % of Phase V
FGD System [b]	78	79	1	1
FSSS + T/G[c]	154	151	(-) 3	(-) 2
Other Mechanical	149	157	8	5
Sub-Total Mechanical	381	387	6	2
Structural	98	94	(-) 4	(-) 4
Electrical/I&C	61	53	(-) 8	(-) 13
Total Direct Costs	540	534	(-) 6	(-) 1
Construction Services	75	77	2	3
Home Office Eng. and Services	32	28	(-) 4	(-) 13
Field Office Eng. and Services	28	23	(-) 5	(-) 18
Total Indirect Costs	135	128	(-) 7	(-) 5
TOTAL BASE CONSTRUCTION COSTS	675	662	(-) 13	(-) 2

(a) Data in Constant $1983
(b) Flue Gas Desulfurization System: Does not Include Commodities for Structures or for Building and Equipment Foundations, Piping, HVAC, I&C or Electric Equipment
(c) Fossil Steam Supply System plus Turbine-Generator Unit

SECTION 6

6.0 CAPITAL COST UPDATE FOR THE 500 MWe COMPARISON POWER PLANT (HS5) AS A MULTI-UNIT STATION

6.1 INTRODUCTION

The HS5 single unit, technical and capital cost data models were updated in the Phase VI Update. This section discusses the changes in design features, plant configuration and costs that were developed for modifying the updated HS5 for application as a two-unit station.

Capital cost data is presented at the three-digit code-of-accounts level of detail for the first unit, the second unit and the total station.

6.2 TWO-UNIT STATION CRITERIA

The technical and capital cost data for the HS5 two-unit station was developed to the same criteria and ground rules as those for the updated single unit plant on which it is based. For the two-unit station, appropriate design and cost changes were made to the single unit plant design for a "first-of-two" and a "second-of-two" unit. In developing the multi-unit data, the following ground rules supplemented the EEDB single-unit ground rules.

- The first unit (Unit 1) of the two-unit station carried the full cost of all common facilities and equipment that are required for its startup, normal operation and shutdown.
- The design features and costs for each two-unit station were based on a "slide-along" configuration approach, with appropriate facility sharing between units.
- Costs reflected simultaneous environmental licensing and purchase of major equipment for both units.
- Lead time between unit commercial operation dates was 12 months to take advantage of the construction labor "learning curve" effect.
- The twin unit design accommodated the environmental licensing requirements and design practice current for two unit stations as of January 1, 1983.

6.3 TWO-UNIT STATION CONFIGURATION

In any multi-unit generating station, the objective of the design and arrangement of the units is to construct the station for the lowest total station costs. Consequently, the total base construction cost of the first unit will be higher than a single unit plant because of the introduction of larger or shared facilities in anticipation of the second unit. By appropriate unit design, plant arrangement and construction procedures, the capital cost of a two (2) unit station may be controlled so that it is less than twice the capital cost of a single unit plant.

In the past, "mirror-image" plant arrangements were used for two-unit stations, in order to minimize interconnecting equipment (e.g., piping, wiring) costs. However, as stations got larger and more complex, the "mirror-image" approach led to costly equipment and construction rework, due to design errors or misinterpretation of construction drawings. The "slide-along" concept has gained acceptance as a cost-effective approach, because it reduces equipment design costs and eliminates potential design/construction confusion.

For the "slide-along" approach, the equipment design and plant general arrangement of the boiler/turbine/flue-gas-desulfurization-system train is identical for each unit. Common auxiliary support systems (e.g., control room, feedwater treatment system and coal handling system) have unique interfacing arrangements for each unit. The common equipment is furnished with the first unit, while the common equipment unit interface components and commodities are furnished with each unit.

The HS5 twin unit station was configured as two "slide-along" units. A plot plan illustrating this configuration is shown on Figure 6.1. Design features common to both units are identified by a distinctive symbol.

6.3.1 First Unit Design

Each unit of the multi-unit station is a 486 MWe high sulfur coal-fired power plant with a sub-critical steam generator operating at 2400 psi and 1000°F reheat temperature. The steam generator is designed to operate with a high sulfur eastern bituminous coal. The unit is equipped with an electrostatic precipitator and a wet lime scrubber system which will clean the effluent gas stream to meet the emission requirements in effect as of January 1, 1983. The two unit station is located at the Middletown site. System design descriptions for each unit are contained in the EEDB Technical Reference Book.[7] A description of the Middletown site is given in the EEDB Program Reference Book.[6]

In the design of the first unit, provision was made for the subsequent second unit by expanding or combining facilities. These shared or common facilities resulted in an increased cost for the first unit but a decreased cost for the second unit. The net effect was to reduce the total cost of the station.

The environmental licensing required for the first unit includes second unit licensing. This applies to liquid, solid and gaseous emissions from each unit and the entire station. The permits issued will apply to both the first unit and the second unit.

6.3.2 Second Unit Design

The second unit was designed to take advantage of the first unit in a number of ways, which are expected to result in lower cost.

- Shared or common facilities.

- Duplicate purchase orders for all major equipment permitted by the "slide-along" concept. (These duplications allow some vendors to offer lower prices for the second unit since their engineering costs do not have to be repeated and their manufacturing costs may be reduced.)

- Shared environmental licensing.

- Increased labor productivity (construction of the second unit is started at approximately the same time as the first unit but moves at a slower pace to efficiently use experienced labor coming off the first unit construction; start-up of the second unit is about one year after the first unit):

  1) Unit 2 construction will benefit from procedures developed for Unit 1.

  2) Unit 2 craft and supervisory personnel will be "unit" experienced and familar with work procedures.

  3) Personnel can be transferred to work on Unit 2, if there is a delay on Unit 1.

- Reduced indirect costs for Unit 2 compared to Unit 1:

  1) Equipment mobilization will not be necessary for Unit 2.

  2) The number/size of temporary buildings will be smaller for Unit 2 because the field job supervision staff is reduced and fewer craft laborers are needed.

  3) The security force during plant construction will expand very little because a second unit is being constructed; most of this cost for Unit 2 is caused by the extended construction schedule.

  4) Much of the construction equipment can be used for the two units without duplication.

  5) Engineering and construction management costs are greatly reduced for a second unit that is identical with and shares common facilities with a "first-of-two" unit.

  6) Field QA/QC and start-up testing can be performed more efficiently for the duplicated Unit 2 systems and may be avoided for the common facilities already provided with Unit 1.

  7) Field job supervision is reduced because less craft manhours are required for Unit 2 than for Unit 1 and because many functions can be shared with a net reduction in supervisors.

8) Reductions in payroll insurance and taxes and in small tools and expendables are directly related to the reduction in craft labor for Unit 2.

The costs which have been developed for the two-unit plant are for an optimized schedule. If the capacity from the second unit cannot be utilized within a year after Unit 1 comes on stream, the labor and schedule related savings will begin to decline. However, a two unit station will almost always be cheaper than two single unit plants because of the shared facilities.

6.4 SHARED FACILITIES DESCRIPTION

Sharing of common facilities for a coal-fired station does not normally pose any safety, regulatory or licensing problems. In the past, the state public utility commissions have not prohibited the use of common facilities between plants.

The design bases for selecting common facilities are stated below.

1. Some plant facilities or systems are designed for intermittent operation. These systems satisfactorily support the normal operation of two units, at the full load output of the system.

   The condensate storage tank is an example of a common facility designed on this basis.

2. Some plant systems are not needed for both plants simultaneously. An example is the auxiliary boiler and building. This facility is designed for the plant needs during start-up. During normal plant operation, the auxiliary boiler is essentially idle. Since both units will not be started simultaneously, an auxiliary boiler having the capacity to support a single unit can meet the needs for two units.

   Examples of common facilities that followed this design are:

   a. Diesel-Generators and Building; and

   b. Fuel Oil Tank.

3. Various plant facilities may be shared that are required for general routine plant maintenance and other activities, because they are independent of unit operation. These facilities included:

   a. Warehouse;

   b. Locomotive Repair Shop;

   c. Coal Pile Runoff Basin;

d. Railroad Sidings (except to the turbine buildings);

e. Administration Building; and

f. Access Roads.

4. Finally, certain plant facilities are normally designed with overcapacity, in order to meet the needs of a single unit in one (eight hour) shift. Two unit operation requires the operation of a second or third shift. The coal handling system is an example of such a facility.

Each unit's coal burn rate is 216 tons/hr at 100 percent load. However, the coal handling system stackout rate (i.e., coal stacked at the coal pile) is 2000 tons/hr. This representative rate (nearly ten times the unit burn rate) was selected to permit a unit train of 10,000 tons to be unloaded in five hours. Therefore, unloading may be accomplished in one eight hour shift with margin to allow for less than optimum unloading conditions, such as poor weather or equipment malfunction.

Similarly, the coal reclaim rate is 550 tons/hr. This overcapacity permits empty coal silos to be refilled while sustaining full load on the unit. The 550 ton/hr rate can service two 500 MWe units (432 tons/hr) at full load. Additionally, current design practice for coal handling systems provides 100 percent redundancy for all conveyor belts and equipment such as breakers and crushers. Thus, the coal silos for both units may be rapidly replenished at a rate of 1100 tons/hr when a unit train is being unloaded, by using both 550 ton/hr reclaiming and crushing system conveyor belts.

The coal handling structures or facilities that were shared include:

a. Rotary Car Dumper;

b. Coal Crusher House;

c. Coal Breaker House;

d. Car Thaw Shed;

e. Coal Handling System Switchgear Building;

f. Active Coal Pile;

g. Stacker Reclaimer; and

h. Stacker Reclaimer Transfer Tower.

Other common facilities based on this design philosophy are:

a. Material Handling Service Building;

b. Temporary FGD Waste Storage Area; and

c. Waste Water Treatment Area.

6.5 REVISIONS TO SYSTEM DESIGN DESCRIPTIONS FOR UNIT 1

System design descriptions for the single-unit HS5 are given in the Technical Reference Book.[7] The scope of the majority of the systems for Unit 1 of a two unit station remain unchanged from that for a single unit plant. However, since some facilities were shared between Unit 1 and Unit 2 in the two-unit station, certain accounts have changed. The shared facilities are identified in Section 6.4. The effect of this sharing was to increase the scope of selected system descriptions for Unit 1 with a corresponding decrease in the scope of the same system descriptions for Unit 2.

The changes in the system design descriptions are given below at the three-digit code-of-accounts level of detail and are identified with the three-digit account number. Accounts omitted from this discussion have the same scope as those for a single unit station.

ACCOUNT 21 STRUCTURES AND IMPROVEMENTS

Account 211 Yardwork

Additional clearing and grubbing was required to support the construction of Unit 2.

Account 213 Turbine, Heater and Control Building

Control and switchgear spaces were expanded to accommodate equipment for Unit 2.

Account 218B Administration and Service Building

Lunchroom space, locker room space and toilet room space were expanded to accommodate operators and maintenance workers for Unit 2. The personnel added at the site to staff Unit 2 will include 20 operators, 58 maintenance workers, four technical personnel and two personnel for the plant manager's office.

Account 218V Waste Water Treatment Building

Equipment space was expanded to accommodate additional equipment capacity required for Unit 2.

ACCOUNT 24 ELECTRIC PLANT EQUIPMENT

Account 245 Electrical Structures and Wiring Containers

Additional equipment was included to service design features common to Units 1 and 2 and furnished with Unit 1.

Account 246 Power and Control Wiring

Additional wiring was included to service design features common to Units 1 and 2 and furnished with Unit 1.

ACCOUNT 25 MISCELLANEOUS PLANT EQUIPMENT

Account 252 Air, Water and Steam Service Systems

Additional or expanded capacity equipment was included to service design features common to Units 1 and 2 and furnished with Unit 1.

ACCOUNT 26 MAIN CONDENSER HEAT REJECTION SYSTEM

Account 261 Structures

One bay was added to the Makeup Water Intake Structure to accommodate equipment for Unit 2.

Account 262 Mechanical Equipment

Additional makeup water intake equipment was provided to service Unit 2.

6.6 REVISIONS TO SYSTEM DESIGN DESCRIPTIONS FOR UNIT 2

Many of the system descriptions for Unit 2 were identical to those for the single-unit station. However, since some facilities were shared with Unit 1, they were not included in the scope of Unit 2. The changes in the system design descriptions are given below at the three-digit code-of-accounts level of detail and are identified with the three-digit account number. Accounts not included have the same scope as those for a single-unit station.

ACCOUNT 21 STRUCTURES AND IMPROVEMENTS

Account 211 Yardwork

Unit 2 scope was reduced to cut-and-fill for structures, turbine building rail siding, sanitary sewers, storm drains and general area lighting.

Account 212 Steam Generator Building

The service area (auxiliary boiler room, machine shop and diesel-generator room) was not included in this account because the Unit 1 area was utilized to accommodate Unit 2.

Account 213 Turbine, Heater and Control Building

Control and switchgear areas were not included in this account because the Unit 1 area was expanded to accommodate Unit 2.

Account 218B Administration and Service Building

This account was not included (part of Unit 1) in Unit 2.

Account 218I Electrical Switchgear Building

This account was not included (part of Unit 1) in Unit 2.

Account 218L Stacker/Reclaimer Transfer Tower

This account was not included (part of Unit 1) in Unit 2.

Account 218M Coal Car Thaw Shed

This account was not included (part of Unit 1) in Unit 2.

Account 218N Rotary Car Dumper Building & Tunnel

This account was not included (part of Unit 1) in Unit 2.

Account 218O Coal Breaker House

This account was not included (part of Unit 1) in Unit 2.

Account 218P Coal Crusher House

This account was not included (part of Unit 1) in Unit 2.

Account 218Q Boiler House Transfer Tower

This account was not included (part of Unit 1) in Unit 2.

Account 218T Locomotive Repair Garage

This account was not included (part of Unit 1) in Unit 2.

Account 218U Material Handling and Service Building

This account was not included (part of Unit 1) in Unit 2.

Account 218V Waste Water Treatment Building

This account was not included (part of Unit 1) in Unit 2.

Account 218W Miscellaneous Coal Handling Structures

An extension gallery from the Unit 1 to Unit 2 tripper galleries was included in this Unit 2 account. The stacker/reclaimer transfer tower and the maintenance and repair shop were omitted from this account because they were common to both units and furnished with Unit 1.

ACCOUNT 22 BOILER PLANT EQUIPMENT

Account 224 Fuel Handling Systems

An extension conveyor and associated equipment from the Unit 1 to Unit 2 tripper galleries were included in this Unit 2 account. Coal handling equipment other than the Unit 2 coal silos, trippers, tripper conveyors, ignition oil system and associated equipment, was omitted from this account because it was common to both units and furnished with Unit 1.

Account 225 Flue Gas Desulfurization Structures

The lime unloading building and process and seal water pumphouse were omitted from this account because they were common to both units and furnished with Unit 1.

Account 226 Desulfurization Equipment

The lime unloading system equipment was omitted from this account because it was common to both units and furnished with Unit 1.

ACCOUNT 23 TURBINE PLANT EQUIPMENT

Account 233 Condensing Systems

The condensate storage tank was omitted from this account because it was common to both units and furnished with Unit 1.

Account 235 Other Turbine Plant Equipment

The demineralized water makeup system was omitted from this account because it was common to both units and furnished with Unit 1.

ACCOUNT 24 ELECTRIC PLANT EQUIPMENT

Account 241 Switchgear

Switchgear was shared that was related to the shared mechanical systems. Switchgear for the following systems was not included in this account for Unit 2.

1. Coal Handling System

2. Lime Unloading System

3. Fire Protection System

4. Make-up Water Pre-treatment System

5. Ignition Oil Supply System

6. Auxiliary Steam System

7. Miscellaneous Small Systems/Equipment

The remaining equipment in this account was duplicated for Unit 2 and had a scope identical to that for Unit 1.

Account 242 Station Service Equipment

The reserve auxiliary transformers and emergency diesel-generator units were shared facilities and were not included in the scope for Unit 2. Wiring and switchgear for utilization of this equipment were included in the Unit 1 scope.

Account 244 Protective Equipment

Grounding for coal handling and other common systems furnished with Unit 1 was omitted from this account for Unit 2.

Account 245 Electrical Structures and Wiring Containers

Equipment servicing common systems furnished with Unit 1 were omitted from this account for Unit 2.

Account 246 Power and Control Wiring

Wiring serving common equipment furnished with Unit 1 was omitted from this account for Unit 2.

ACCOUNT 25 MISCELLANEOUS PLANT EQUIPMENT

Account 251 Transportation and Lifting Equipment

The diesel-generator unit room crane, diesel locomotive and one bulldozer were omitted from this account because they were common to both units and furnished with Unit 1.

Account 252 Air, Water and Steam Service System

The auxiliary boiler and certain components of the fire protection system were omitted from this account because they were common to both units and furnished with Unit 1. Components and equipment serving common systems furnished with Unit 1 were also omitted from this account.

Account 253 Communications Equipment

The general telephone system and security system were omitted from this account because they were common to both units and furnished with Unit 1.

Account 254 Furnishings and Fixtures

Furnishings and fixtures shared between units or serving shared design features were omitted from this account because they were provided with Unit 1.

Account 255 Waste Water Treatment Equipment

Equipment required to extend the capacity of the Unit 1 waste water treatment systems by 40 percent to service Unit 2 was included in this account for Unit 2.

ACCOUNT 26 MAIN CONDENSER HEAT REJECTION SYSTEM

Account 261 Structures

The make-up water intake structure and the makeup water pretreatment building were omitted from this account because they were common to both units and furnished with Unit 1.

Account 262 Mechanical Equipment

The make-up water intake and pretreatment equipment were omitted from this account because they were common to both units and furnished with Unit 1.

6.7 COST ESTIMATES FOR THE MULTI-UNIT HS5

A comparison of the cost for two single-unit HS5 plants was made with the two-unit HS5 station and is presented in Table 6-1. This table indicates the percentage reduction by account achieved for the two-unit station over the single-unit station. The overall reduction is 12 percent. The table also gives the Unit 2/Unit 1 cost ratios for each cost account for the multi-unit station. The Unit 2 total base cost is approximately 75 percent of that of Unit 1.

Tables 6-2 and 6-3 provide detailed breakdowns for the first (Unit 1) and second (Unit 2) units of the multi-unit station. Each cost estimate is given at the three-digit code-of-accounts level of detail in terms of factory equipment, site labor, site material and total costs for each direct and indirect cost account. The "three-digit level" cost estimate for the two-unit HS5 station is given in Table 6-4.

The cost differences reflected in Tables 6-1 through 6-4 were caused by the factors identified and discussed in Sections 6.3 through 6.6. Accounts having identical system descriptions for Units 1 and 2 and lower Unit 2 costs in Table 6-4 reflect improved Unit 2 labor utilization or reduced equipment costs.

TABLE 6-1

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COMPARISON OF SINGLE-UNIT AND TWO-UNIT
HS5[a] CAPITAL COSTS
($1983 x 10^6)[b]

Account No.	Description	Two Single-Units	Multi (Two)-Unit	Percent Cost Reduction	Multi-Unit Cost Ratio (2nd Unit/ 1st Unit)
21	Structures & Improvements	115	97	16	0.66
22	Boiler Plant Equipment	396	361	9	0.82
23	Turbine Plant Equipment	159	156	2	0.96
24	Electric Plant Equipment	70	64	9	0.82
25	Miscellaneous Plant Equipment	40	30	25	0.51
26	Main Condenser Heat Rejection Sys.	32	30	6	0.84
2	TOTAL DIRECT COSTS	812	738	9	0.81
91	Construction Services	122	97	20	0.60
92	Home Office Eng. & Services	42	29	31	0.35
93	Field Office Eng. & Services	36	30	17	0.64
9	TOTAL INDIRECT COSTS	200	156	22	0.55
BASE CONSTRUCTION COSTS		1,012	894	12	0.76

(a) 486 MWe High-Sulfur Coal-Fired Power Generating Station
(b) Data in Constant $1983

TABLE 6-2

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
1ST UNIT OF A TWO-UNIT HS5(a)
MIDDLETOWN, USA

486 MWe UNIT 1 COST BREAKDOWN
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Total Cost ($)	Factory Equipment Cost ($)	Site Labor Cost ($)	Site Material Cost ($)	Comments
21.	Structures & Improvements	58,505,447	2,131,884	23,164,715	33,208,848	Total
211.	Yardwork	9,339,218	181,165	4,579,651	4,578,402	
212.	Steam Generator Building	19,315,964	745,342	6,582,804	11,987,818	
213.	Turbine, Heater and Control Building	12,540,075	483,554	4,684,790	7,371,731	
218B.	Administration & Service Building	2,669,080	290,580	1,142,149	1,236,351	
218I.	Electrical Switchgear Building	182,520	25,904	105,329	51,287	
218L.	Stacker/Reclaimer Transfer Tower	202,826	5,606	118,569	78,651	

(a) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-2

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
1ST UNIT OF A TWO-UNIT HS5(a)
MIDDLETOWN, USA

486 MWe UNIT 1 COST BREAKDOWN
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Total Cost ($)	Factory Equipment Cost ($)	Site Labor Cost ($)	Site Material Cost ($)	Comments
218M.	Coal Car Thaw Shed	70,974	-0-	49,958	21,016	
218N.	Rotary Car Dumper Building & Tunnel	1,346,554	5,718	771,956	568,880	
218O.	Coal Breaker House	957,677	92,794	357,487	507,396	
218P.	Coal Crusher House	648,190	116,260	257,040	274,890	
218Q.	Boiler House Transfer Tower	145,881	2,367	48,903	94,611	
218R.	Dead Storage Transfer Tunnel	995,178	-0-	645,982	349,196	
218T.	Locomotive Repair Garage	226,839	18,984	101,561	106,294	
218U.	Material Handling & Service Building	451,193	22,536	207,296	221,361	

(a) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-2

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
1ST UNIT OF A TWO-UNIT HS5(a)
MIDDLETOWN, USA

486 MWe UNIT 1 COST BREAKDOWN
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Total Cost ($)	Factory Equipment Cost ($)	Site Labor Cost ($)	Site Material Cost ($)	Comments
218V.	Waste Water Treatment Building	272,266	7,474	148,075	116,717	
218W.	Miscellaneous Coal Handling Structures	3,244,155	133,600	1,315,632	1,794,923	
219.	Stack Structure	5,896,857	-0-	2,047,533	3,849,324	
22.	Boiler Plant Equipment	197,983,129	132,287,089	47,086,368	18,609,672	Total
220A.	Fossil Steam Supply System	62,009,500	49,728,000	11,165,000	1,116,500	
221.	Steam Generating System	1,897,134	1,268,903	566,548	61,683	
222.	Draft System	17,530,227	7,541,504	4,936,471	5,052,252	
223.	Ash & Dust Handling System	5,731,942	3,937,000	1,602,821	192,121	

(a) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-2

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
1ST UNIT OF A TWO-UNIT HS5[a]
MIDDLETOWN, USA

486 MWe UNIT 1 COST BREAKDOWN
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Total Cost ($)	Factory Equipment Cost ($)	Site Labor Cost ($)	Site Material Cost ($)	Comments
224.	Fuel Handling Systems	20,126,078	15,505,805	3,821,439	798,834	
225.	Flue Gas Desulfurization Structures	9,671,350	1,850,000	3,581,350	4,240,000	
226.	Desulfurization Equipment	72,482,947	48,047,618	18,688,168	5,747,161	
227.	Instrumentation & Control	5,817,423	4,170,916	1,537,353	109,154	
228.	Boiler Plant Miscellaneous Items	2,716,528	237,343	1,187,218	1,291,967	
23 .	Turbine Plant Equipment	79,447,158	61,371,723	14,196,081	3,879,354	Total

(a) 2 x 486 MWe High Sulfur Coal-Fired Power Generating Station

TABLE 6-2

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
1ST UNIT OF A TWO-UNIT HS5[a]
MIDDLETOWN, USA

486 MWe UNIT 1 COST BREAKDOWN
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Total Cost ($)	Factory Equipment Cost ($)	Site Labor Cost ($)	Site Material Cost ($)	Comments
231.	Turbine Generator	46,881,170	41,771,063	4,050,532	1,059,575	
233.	Condensing Systems	8,058,771	6,061,664	1,600,559	396,548	
234.	Feed Heating System	10,330,939	7,334,197	2,722,158	274,584	
235.	Other Turbine Plant Equipment	11,192,611	6,075,245	4,628,285	489,081	
236.	Instrumentation & Control	143,906	129,554	13,668	684	
237.	Turbine Plant Miscellaneous Items	2,839,761	-0-	1,180,879	1,658,882	
24.	Electric Plant Equipment	35,359,937	12,819,980	13,432,697	9,107,260	Total
241.	Switchgear	6,959,800	6,581,481	319,999	58,320	

(a) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-2

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
1ST UNIT OF A TWO-UNIT HS5[a]
MIDDLETOWN, USA

486 MWe UNIT 1 COST BREAKDOWN
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Total Cost ($)	Factory Equipment Cost ($)	Site Labor Cost ($)	Site Material Cost ($)	Comments
242.	Station Service Equipment	5,536,430	4,848,791	562,084	125,555	
243.	Switchboards	1,037,644	769,919	174,466	93,259	
244.	Protective Equipment	2,877,747	-0-	1,612,827	1,264,920	
245.	Electrical Structures & Wiring Containers	9,586,951	-0-	7,218,353	2,368,598	
246.	Power & Control Wiring	9,361,365	619,789	3,544,968	5,196,608	
25.	Miscellaneous Plant Equipment	20,091,528	9,578,798	8,790,212	1,722,518	Total
251.	Transportation & Lift Equipment	2,318,549	1,746,806	314,615	257,128	
252.	Air, Water & Steam Service Systems	9,481,256	4,293,416	4,345,227	842,613	

(a) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

Cost Basis
1/83

TABLE 6-2

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
1ST UNIT OF A TWO-UNIT HS5(a)
MIDDLETOWN, USA

486 MWe UNIT 1 COST BREAKDOWN
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Total Cost ($)	Factory Equipment Cost ($)	Site Labor Cost ($)	Site Material Cost ($)	Comments
253.	Communications Equipment	1,422,404	191,260	964,161	266,983	
254.	Furnishings & Fixtures	1,102,262	846,671	223,505	32,086	
255.	Waste Water Treatment Equipment	5,767,057	2,500,645	2,942,704	323,708	
26.	Main Condenser Heat Rejection System	16,536,167	8,421,695	6,077,118	2,037,354	Total
261.	Structures	2,428,297	176,157	1,296,564	955,576	
262.	Mechanical Equipment	14,107,870	8,245,538	4,780,554	1,081,778	
2.	TOTAL DIRECT COSTS	407,923,366	226,611,169	112,747,191	68,565,006	Total Direct Costs
91.	Construction Services	60,905,000	22,400,000	19,085,000	19,420,000	Total

(a) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-2

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
1ST UNIT OF A TWO-UNIT HS5[a]
MIDDLETOWN, USA

486 MWe UNIT 1 COST BREAKDOWN
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Total Cost ($)	Factory Equipment Cost ($)	Site Labor Cost ($)	Site Material Cost ($)	Comments
911.	Temporary Construction Facilities	23,275,000	-0-	16,635,000	6,640,000	
912.	Construction Tools & Equipment	14,710,000	-0-	2,450,000	12,260,000	
913.	Payroll Insurance & Taxes	22,400,000	22,400,000	-0-	-0-	
914.	Permits, Insurance & Local Taxes	520,000	-0-	-0-	520,000	
92.	Home Office Engineering & Services	21,210,000	21,210,000	-0-	-0-	Total
921.	Home Office Services	19,420,000	19,420,000	-0-	-0-	
923.	Home Office Construction Management	1,790,000	1,790,000	-0-	-0-	

(a) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

Cost Basis
1/83

TABLE 6-2

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
1ST UNIT OF A TWO-UNIT HS5[a]
MIDDLETOWN, USA

486 MWe UNIT 1 COST BREAKDOWN
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Total Cost ($)	Factory Equipment Cost ($)	Site Labor Cost ($)	Site Material Cost ($)	Comments
93.	Field Office Engineering & Services	18,125,000	16,635,000	-0-	1,490,000	Total
931.	Field Office Expenses	1,490,000	-0-	-0-	1,490,000	
932.	Field Job Supervision	15,500,000	15,500,000	-0-	-0-	
933.	Field QA/QC	425,000	425,000	-0-	-0-	
934.	Plant Startup & Test	710,000	710,000	-0-	-0-	
9.	TOTAL INDIRECT COSTS	100,240,000	60,245,000	19,085,000	20,910,000	Total Indirect Costs
	TOTAL BASE COST	508,163,366	286,856,169	131,832,191	89,475,006	Total Base Cost

(a) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-3

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
2ND UNIT OF A TWO-UNIT HS5(a)
MIDDLETOWN, USA

486 MWe UNIT 2 COST BREAKDOWN
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Total Cost ($)	Factory Equipment Cost ($)	Site Labor Cost ($)	Site Material Cost ($)	Comments
21.	Structures & Improvements	38,890,011	1,264,123	13,873,266	23,752,622	Total
211.	Yardwork	1,292,080	-0-	765,593	526,487	
212.	Steam Generator Building	18,093,693	699,131	5,922,220	11,472,342	
213.	Turbine, Heater and Control Building	10,730,428	431,392	3,851,437	6,447,599	
218B.	Administration & Service Building	-0-	-0-	-0-	-0-	
218I.	Electrical Switchgear Building	-0-	-0-	-0-	-0-	
218L.	Stacker/Reclaimer Transfer Tower	-0-	-0-	-0-	-0-	

(a) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-3

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
2ND UNIT OF A TWO-UNIT HS5[a]
MIDDLETOWN, USA

486 MWe UNIT 2 COST BREAKDOWN
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Total Cost ($)	Factory Equipment Cost ($)	Site Labor Cost ($)	Site Material Cost ($)	Comments
218M.	Coal Car Thaw Shed	-0-	-0-	-0-	-0-	
218N.	Rotary Car Dumper Building & Tunnel	-0-	-0-	-0-	-0-	
218O.	Coal Breaker House	-0-	-0-	-0-	-0-	
218P.	Coal Crusher House	-0-	-0-	-0-	-0-	
218Q.	Boiler House Transfer Tower	-0-	-0-	-0-	-0-	
218R.	Dead Storage Transfer Tunnel	962,831	-0-	613,635	349,196	
218T.	Locomotive Repair Garage	-0-	-0-	-0-	-0-	
218U.	Material Handling & Service Building	-0-	-0-	-0-	-0-	

(a) 2 x 486 MWe High Sulfur Coal-Fired Power Generating Station

TABLE 6-3

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
2ND UNIT OF A TWO-UNIT HS5[a]
MIDDLETOWN, USA

486 MWe UNIT 2 COST BREAKDOWN
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Total Cost ($)	Factory Equipment Cost ($)	Site Labor Cost ($)	Site Material Cost ($)	Comments
218V.	Waste Water Treatment Building	-0-	-0-	-0-	-0-	
218W.	Miscellaneous Coal Handling Structures	2,192,182	133,600	773,908	1,284,674	
219.	Stack Structure	5,618,797	-0-	1,946,473	3,672,324	
22.	Boiler Plant Equipment	162,188,768	107,040,919	40,411,924	14,735,925	Total
220A.	Fossil Steam Supply System	56,422,625	44,755,200	10,606,750	1,060,675	
221.	Steam Generating System	1,865,974	1,268,903	538,221	58,850	
222.	Draft System	14,156,536	6,956,504	4,689,647	2,510,385	
223.	Ash & Dust Handling System	5,478,801	3,772,000	1,522,680	184,121	

(a) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

Cost Basis
1/83

TABLE 6-3

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
2ND UNIT OF A TWO-UNIT HS5[a]
MIDDLETOWN, USA

486 MWe UNIT 2 COST BREAKDOWN
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Total Cost ($)	Factory Equipment Cost ($)	Site Labor Cost ($)	Site Material Cost ($)	Comments
224.	Fuel Handling Systems	2,906,000	1,729,835	689,055	487,110	
225.	Flue Gas Desulfurization Structures	8,162,198	1,842,600	2,857,638	3,461,960	
226.	Desulfurization Equipment	64,804,370	42,307,618	16,919,591	5,577,161	
227.	Instrumentation & Control	5,735,097	4,170,916	1,460,485	103,696	
228.	Boiler Plant Miscellaneous Items	2,657,167	237,343	1,127,857	1,291,967	
23.	Turbine Plant Equipment	76,012,579	59,198,168	13,258,068	3,556,343	Total

(a) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-3

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
2ND UNIT OF A TWO-UNIT HS5[a]
MIDDLETOWN, USA

486 MWe UNIT 2 COST BREAKDOWN
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Total Cost ($)	Factory Equipment Cost ($)	Site Labor Cost ($)	Site Material Cost ($)	Comments
231.	Turbine Generator	45,830,607	40,943,027	3,848,005	1,039,575	
233.	Condensing Systems	7,347,429	5,850,363	1,360,846	136,220	
234.	Feed Heating System	9,976,941	7,129,807	2,586,050	261,084	
235.	Other Turbine Plant Equipment	9,933,696	5,145,417	4,328,347	459,932	
236.	Instrumentation & Control	143,189	129,554	12,985	650	
237.	Turbine Plant Miscellaneous Items	2,780,717	-0-	1,121,835	1,658,882	
24.	Electric Plant Equipment	29,015,332	10,305,015	10,966,980	7,743,337	Total
241.	Switchgear	5,900,930	5,594,259	258,399	48,272	

(a) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-3

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
2ND UNIT OF A TWO-UNIT HS5(a)
MIDDLETOWN, USA

486 MWe UNIT 2 COST BREAKDOWN
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Total Cost ($)	Factory Equipment Cost ($)	Site Labor Cost ($)	Site Material Cost ($)	Comments
242.	Station Service Equipment	3,930,616	3,433,791	420,127	76,698	
243.	Switchboards	1,028,052	769,919	165,743	92,390	
244.	Protective Equipment	2,663,474	-0-	1,458,212	1,205,262	
245.	Electrical Structures & Wiring Containers	7,798,986	-0-	5,802,336	1,996,650	
246.	Power & Control Wiring	7,693,274	507,046	2,862,163	4,324,065	
25.	Miscellaneous Plant Equipment	10,165,785	4,138,757	4,913,374	1,113,654	Total
251.	Transportation & Lift Equipment	1,190,836	733,528	250,415	206,893	
252.	Air, Water & Steam Service Systems	5,459,020	2,022,908	2,863,651	572,461	

(a) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-3

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
2ND UNIT OF A TWO-UNIT HS5[a]
MIDDLETOWN, USA

486 MWe UNIT 2 COST BREAKDOWN
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Total Cost ($)	Factory Equipment Cost ($)	Site Labor Cost ($)	Site Material Cost ($)	Comments
253.	Communications Equipment	1,010,858	124,695	689,326	196,837	
254.	Furnishings & Fixtures	368,344	284,481	61,788	22,075	
255.	Waste Water Treatment Equipment	2,136,727	973,145	1,048,194	115,388	
26.	Main Condenser Heat Rejection System	13,958,746	7,641,288	4,987,313	1,330,145	Total
261.	Structures	1,025,434	121,629	600,546	303,259	
262.	Mechanical Equipment	12,933,312	7,519,659	4,386,767	1,026,886	
2.	TOTAL DIRECT COSTS	330,231,221	189,588,270	88,410,925	52,232,026	Total Direct Costs
91.	Construction Services	36,272,060	16,710,000	9,889,380	9,672,680	Total

(a) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

Cost Basis
1/83

TABLE 6-3

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
2ND UNIT OF A TWO-UNIT HS5[a]
MIDDLETOWN, USA

486 MWe UNIT 2 COST BREAKDOWN
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Total Cost ($)	Factory Equipment Cost ($)	Site Labor Cost ($)	Site Material Cost ($)	Comments
911.	Temporary Construction Facilities	11,007,610	-0-	8,750,010	2,257,600	
912.	Construction Tools & Equipment	8,169,450	-0-	1,139,370	7,030,080	
913.	Payroll Insurance & Taxes	16,710,000	16,710,000	-0-	-0-	
914.	Permits, Insurance & Local Taxes	385,000	-0-	-0-	385,000	
92.	Home Office Engineering & Services	7,423,500	7,423,500	-0-	-0-	Total
921.	Home Office Services	6,797,000	6,797,000	-0-	-0-	
923.	Home Office Construction Management	626,500	626,500	-0-	-0-	

(a) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-3

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
2ND UNIT OF A TWO-UNIT HS5(a)
MIDDLETOWN, USA

486 MWe UNIT 2 COST BREAKDOWN
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Total Cost ($)	Factory Equipment Cost ($)	Site Labor Cost ($)	Site Material Cost ($)	Comments
93.	Field Office Engineering & Services	11,626,000	10,881,000	-0-	745,000	Total
931.	Field Office Expenses	745,000	-0-	-0-	745,000	
932.	Field Job Supervision	10,200,000	10,200,000	-0-	-0-	
933.	Field QA/QC	255,000	255,000	-0-	-0-	
934.	Plant Startup & Text	426,000	426,000	-0-	-0-	
9.	TOTAL INDIRECT COSTS	55,321,560	35,014,500	9,889,380	10,417,680	Total Indirect Costs
	TOTAL BASE COST	385,552,781	224,602,770	98,300,305	62,649,706	Total Base Cost

(a) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-4

Cost Bas
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
SINGLE UNIT HS5[a] AND TWO UNIT HS5[b]
MIDDLETOWN, USA
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Single Unit Station Cost ($)	Two Unit Station Cost			Comments
			Total ($)	Unit 1 ($)	Unit 2 ($)	
21.	Structures and Improvements	57,301,854	97,395,458	58,505,447	38,890,011	Total
211.	Yardwork	8,808,409	10,631,298	9,339,218	1,292,080	General site work and site access for both units, including rail and road system for handling coal, lime and waste, provided with Unit 1.
212.	Steam Generator Building	19,315,964	37,409,657	19,315,964	18,093,693	Service area (auxiliary boiler room, machine shop, and diesel-generator room) common to both units and charged to Unit 1.
213.	Turbine, Heater, and Control Building	12,083,241	23,270,503	12,540,075	10,730,428	Facility is larger than that for single unit to accommodate future Unit 2 control and switchgear areas. Control and switchgear areas common to both units and charged to Unit 1.

(a) 1 x 486 MWe High-Sulfur Coal-Fired Power Generating Station
(b) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-4

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
SINGLE UNIT HS5[a] AND TWO UNIT HS5[b]
MIDDLETOWN, USA
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Single Unit Station Cost ($)	Two Unit Station Cost			Comments
			Total ($)	Unit 1 ($)	Unit 2 ($)	
218B.	Administration & Service Building	2,486,223	2,669,080	2,669,080	-0-	Structure is larger than that for single unit to accommodate additional office space and locker facilities required for future Unit 2. Common to both units and charged to Unit 1.
None.	Fire Pumphouse	N/A	N/A	N/A	N/A	Included as part of makeup water intake structure, Account 261. Unit 1 facility can service Unit 2.
218I.	Electrical Switchgear Buildings	182,520	182,520	182,520	-0-	Coal handling switchgear building common to both units and charged to Unit 1.
218L.	Stacker/Reclaimer Transfer Tower	202,826	202,826	202,826	-0-	Common to both units and charged to Unit 1. Structure for Unit 1 can service Unit 2.

(a) [redacted] x 486 MWe High-Sulfur Coal-Fired Power Generating Station
(b) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-4

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
SINGLE UNIT HS5[a] AND TWO UNIT HS5[b]
MIDDLETOWN, USA
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Single Unit Station Cost ($)	Two Unit Station Cost			Comments
			Total ($)	Unit 1 ($)	Unit 2 ($)	
218M.	Coal Car Thaw Shed	70,974	70,974	70,974	-0-	Common to both units and charged to Unit 1. Structure for Unit 1 can service Unit 2.
218N.	Rotary Car Dumper Building & Tunnel	1,346,554	1,346,554	1,346,554	-0-	Common to both units and charged to Unit 1. Facility for Unit 1 can service Unit 2 by increasing operating time into second shift as required.
2180.	Coal Breaker House	957,677	957,677	957,677	-0-	Common to both units and charged to Unit 1.
218P.	Coal Crusher House	648,190	648,190	648,190	-0-	Common to both units and charged to Unit 1.
218Q.	Boiler House Transfer Tower	145,881	145,881	145,881	-0-	Common to both units and charged to Unit 1. Facilities for Unit 1 can service Unit 2.

(a) 1 x 486 MWe High-Sulfur Coal-Fired Power Generating Station
(b) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-4

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
SINGLE UNIT HS5[a] AND TWO UNIT HS5[b]
MIDDLETOWN, USA
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Single Unit Station Cost ($)	Two Unit Station Cost			Comments
			Total ($)	Unit 1 ($)	Unit 2 ($)	
218R.	Dead Storage Transfer Tunnel	995,178	1,958,009	995,178	962,831	Separate facility required for each unit.
218T.	Locomotive Repair Garage	226,839	226,839	226,839	-0-	Common to both units and charged to Unit 1. Facilities for Unit 1 can service Unit 2.
218U.	Material Handling & Service Building	451,193	451,193	451,193	-0-	
218V.	Waste Water Treatment Building	239,173	272,266	272,266	-0-	Structure is larger than that for a single unit to accommodate additional capacity for future Unit 2. Common to both units and charged to Unit 1.
218W.	Miscellaneous Coal Handling Structures	3,244,155	5,436,337	3,244,155	2,192,182	a) Separate tripper galleries required for Unit 2 and an extension from Unit 1 galleries.

(a) 1 x 486 MWe High-Sulfur Coal-Fired Power Generating Station
(b) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-4

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
SINGLE UNIT HS5[a] AND TWO UNIT HS5[b]
MIDDLETOWN, USA
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Single Unit Station Cost ($)	Two Unit Station Cost			Comments
			Total ($)	Unit 1 ($)	Unit 2 ($)	
218W. (cont'd)	Miscellaneous Coal Handling Structures (cont'd)					b) Coal pile membrane barrier system and runoff basin are extended when Unit 2 is built. c) Stacker/reclaimer transfer tower common to both units and charged to Unit 1. d) Maintenance and Repair Shop is common for both units and charged to Unit 1. Facilities for Unit 1 can service Unit 2.
219.	Stack Structure	5,896,857	11,515,654	5,896,857	5,618,797	Separate facilities required for each unit.
22.	Boiler Plant Equipment	197,983,129	360,171,897	197,983,129	162,188,768	Total

(a) 1 x 486 MWe High-Sulfur Coal-Fired Power Generating Station
(b) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-4

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
SINGLE UNIT HS5[a] AND TWO UNIT HS5[b]
MIDDLETOWN, USA
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Single Unit Station Cost ($)	Two Unit Station Cost			Comments
			Total ($)	Unit 1 ($)	Unit 2 ($)	
220A.	Fossil Steam Supply System	62,009,500	118,432,125	62,009,500	56,422,625	Separate equipment required for each unit.
221.	Steam Generating System	1,897,134	3,763,108	1,897,134	1,865,974	
222.	Draft System	17,530,227	31,686,763	17,530,227	14,156,536	Separate equipment required for each unit.
223.	Ash & Dust Handling System	5,731,942	11,210,743	5,731,942	5,478,801	
224.	Fuel Handling Systems	20,126,078	23,032,078	20,126,078	2,906,000	Yard equipment is sized for both units and charged to Unit 1. Additional coal silos, trippers, tripper conveyors, ignition oil system and associated equipment are provided in the Unit 2 boiler house.

(a) 1 x 486 MWe High-Sulfur Coal-Fired Power Generating Station
(b) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-4

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
SINGLE UNIT HS5[a] AND TWO UNIT HS5[b]
MIDDLETOWN, USA
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Single Unit Station Cost ($)	Two Unit Station Cost			Comments
			Total ($)	Unit 1 ($)	Unit 2 ($)	
225.	Flue Gas Desulfurization Structures	9,671,350	17,833,548	9,671,350	8,162,198	The lime unloading building and process and seal water pump house are common to both units and charged to Unit 1. Facilities for Unit 1 can service Unit 2. All other structures are duplicated when Unit 2 is built.
226.	Desulfurization Equipment	72,482,947	137,287,317	72,482,947	64,804,370	Lime handling system equipment is common to both units and charged to Unit 1. All other systems are duplicated when Unit 2 is built.
227.	Instrumentation & Control	5,817,423	11,552,520	5,817,423	5,735,097	Separate equipment required for each unit.
228.	Boiler Plant Miscellaneous Items	2,716,528	5,373,695	2,716,528	2,657,167	

(a) 1 x 486 MWe High-Sulfur Coal-Fired Power Generating Station
(b) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-4

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
SINGLE UNIT HS5[a] AND TWO UNIT HS5[b]
MIDDLETOWN, USA
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Single Unit Station Cost ($)	Two Unit Station Cost			Comments
			Total ($)	Unit 1 ($)	Unit 2 ($)	
23.	Turbine Plant Equipment	79,447,158	155,459,737	79,447,158	76,012,579	Total
231.	Turbine Generator	46,881,170	92,711,777	46,881,170	45,830,607	Separate equipment required for each unit.
233.	Condensing Systems	8,058,771	15,406,200	8,058,771	7,347,429	Separate equipment required for each unit. However, the condensate storage tank for the single unit plant is common for Units 1 & 2 and will service both units when Unit 2 is built.
234.	Feed Heating System	10,330,939	20,307,880	10,330,939	9,976,941	Separate equipment required for each unit.

(a) 1 x 486 MWe High-Sulfur Coal-Fired Power Generating Station
(b) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-4

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
SINGLE UNIT HS5[a] AND TWO UNIT HS5[b]
MIDDLETOWN, USA
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Single Unit Station Cost ($)	Two Unit Station Cost			Comments
			Total ($)	Unit 1 ($)	Unit 2 ($)	
235.	Other Turbine Plant Equipment	11,192,611	21,126,307	11,192,611	9,933,696	Separate equipment required for each unit, except for the demineralized water makeup system, which is common to both units and charged to Unit 1
236.	Instrumentation & Control	143,906	287,095	143,906	143,189	Separate equipment required for each unit.
237.	Turbine Plant Miscellaneous Items	2,839,761	5,620,478	2,839,761	2,780,717	
24.	Electric Plant Equipment	35,177,699	64,375,269	35,359,937	29,015,332	Total
241.	Switchgear	6,959,800	12,860,730	6,959,800	5,900,930	Separate switchgear required for each unit, except for coal handling and other equipment common to both units, and charged to Unit 1.

(a) 1 x 486 MWe High-Sulfur Coal-Fired Power Generating Station
(b) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-4

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
SINGLE UNIT HS5[a] AND TWO UNIT HS5[b]
MIDDLETOWN, USA
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Single Unit Station Cost ($)	Two Unit Station Cost			Comments
			Total ($)	Unit 1 ($)	Unit 2 ($)	
242.	Station Service Equipment	5,536,430	9,467,046	5,536,430	3,930,616	Separate equipment required for each unit except for the diesel-generators and reserve auxiliary transformers, which are common to both units and charged to Unit 1.
243.	Switchboards	1,037,644	2,065,696	1,037,644	1,028,052	Separate equipment required for each unit.
244.	Protective Equipment	2,877,747	5,541,221	2,877,747	2,663,474	Separate equipment required for each unit except for the grounding systems for coal handling and waste water treatment areas which are common to both units and charged to Unit 1.

(a) 1 x 486 MWe High-Sulfur Coal-Fired Power Generating Station
(b) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-4

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
SINGLE UNIT HS5[a] AND TWO UNIT HS5[b]
MIDDLETOWN, USA
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Single Unit Station Cost ($)	Two Unit Station Cost			Comments
			Total ($)	Unit 1 ($)	Unit 2 ($)	
245.	Electrical Structures & Wiring Containers	9,535,355	17,385,937	9,586,951	7,798,986	Unit 1 cost includes cost of equipment to service facilities common with future Unit 2.
246.	Power & Control Wiring	9,230,723	17,054,639	9,361,365	7,693,274	Unit 1 cost includes cost of equipment to service facilities common with future Unit 2.
25.	Miscellaneous Plant Equipment	19,996,759	30,257,313	20,091,528	10,165,785	Total
251.	Transportation & Lift Equipment	2,318,549	3,509,385	2,318,549	1,190,836	Separate equipment required for each unit, except for the diesel-generator room cranes and diesel locomotive, which are common to both units and charged to Unit 1. One additional bulldozer is required for and charged to Unit 2.

(a) 1 x 486 MWe High-Sulfur Coal-Fired Power Generating Station
(b) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

Cost Basis
1/83

TABLE 6-4

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
SINGLE UNIT HS5[a] AND TWO UNIT HS5[b]
MIDDLETOWN, USA
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Single Unit Station Cost ($)	Two Unit Station Cost			Comments
			Total ($)	Unit 1 ($)	Unit 2 ($)	
252.	Air, Water & Steam Service Systems	9,386,487	14,940,276	9,481,256	5,459,020	Separate equipment required for each unit, except for auxiliary boiler and certain fire protection system components which are common to both units, and charged to Unit 1. Costs for Unit 1 includes cost of equipment to service facilities common with future Unit 2.
253.	Communications Equipment	1,422,404	2,433,262	1,422,404	1,010,858	Separate equipment required for each unit, except for general telephone system and security system which are charged to Unit 1.
254.	Furnishings & Fixtures	1,102,262	1,470,606	1,102,262	368,344	Many Unit 1 furnishings and fixtures are shared with Unit 2 and charged to Unit 1.

(a) 1 x 486 MWe High-Sulfur Coal-Fired Power Generating Station
(b) [redacted] x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-4

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
SINGLE UNIT HS5[a] AND TWO UNIT HS5[b]
MIDDLETOWN, USA
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Single Unit Station Cost ($)	Two Unit Station Cost			Comments
			Total ($)	Unit 1 ($)	Unit 2 ($)	
255.	Waste Water Treatment Equipment	5,767,057	7,903,784	5,767,057	2,136,727	Capacity increased by 40% when Unit 2 is built. Unit 2 equipment and inter-connecting piping charged to Unit 2.
26.	Main Condenser Heat Rejection System	16,236,028	30,494,913	16,536,167	13,958,746	Total
261.	Structures	2,287,783	3,453,731	2,428,297	1,025,434	Makeup water intake and water pretreatment structure common to both units and charged to Unit 1. One bay added to Unit 1 makeup water intake structure to service future Unit 2.

(a) 1 x 486 MWe High-Sulfur Coal-Fired Power Generating Station
(b) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-4

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
SINGLE UNIT HS5[a] AND TWO UNIT HS5[b]
MIDDLETOWN, USA
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Single Unit Station Cost ($)	Two Unit Station Cost			Comments
			Total ($)	Unit 1 ($)	Unit 2 ($)	
262.	Mechanical Equipment	13,948,245	27,041,182	14,107,870	12,933,312	Separate equipment required for each unit, except make-up water intake equipment which is common to both units and charged to Unit 1. However, capacity and makeup water intake equipment is increased to accommodate future Unit 2.
2.	TOTAL DIRECT COSTS	406,142,627	738,154,587	407,923,366	330,231,221	Total Direct Costs
91.	Construction Services	60,745,000	97,177,060	60,905,000	36,272,060	Total
911.	Temporary Construction Facilities	23,275,000	34,282,610	23,275,000	11,007,610	Unit 2 costs reflect the greater scope of work and longer schedule required for a two unit station vs. a single unit station, based upon UE&C experience.
912.	Construction Tools & Equipment	14,650,000	22,879,450	14,710,000	8,169,450	

(a) 1 x 486 MWe High-Sulfur Coal-Fired Power Generating Station
(b) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-4

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
SINGLE UNIT HS5(a) AND TWO UNIT HS5(b)
MIDDLETOWN, USA
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Single Unit Station Cost ($)	Two Unit Station Cost			Comments
			Total ($)	Unit 1 ($)	Unit 2 ($)	
913.	Payroll Insurance & Taxes	22,300,000	39,110,000	22,400,000	16,710,000	Proportional to total direct plus indirect site labor costs.
914.	Permits, Insurance & Local Taxes	520,000	905,000	520,000	385,000	Builders all risk insurance premiums for Units 1 and 2 proportional to total base cost.
92.	Home Office Engineering & Services	21,210,000	28,633,500	21,210,000	7,423,500	Total
921.	Home Office Services	19,420,000	26,217,000	19,420,000	6,797,000	Unit 2 costs reflect the greater scope of work and longer schedule required for a two unit station vs. a single unit station, based upon UE&C experience.
923.	Home Office Construction Management	1,790,000	2,416,500	1,790,000	626,500	
93.	Field Office Engineering & Services	18,065,000	29,751,000	18,125,000	11,626,000	Total

(a) 1 x 486 MWe High-Sulfur Coal-Fired Power Generating Station
(b) 2 x 486 MWe High-Sulfur Coal-Fired Power Generating Station

TABLE 6-4

Cost Basis
1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST ESTIMATE SUMMARY - THREE DIGIT LEVEL
SINGLE UNIT HS5[a] AND TWO UNIT HS5[b]
MIDDLETOWN, USA
(1983 CONSTANT DOLLARS)

Account No.	Account Description	Single Unit Station Cost ($)	Two Unit Station Cost			Comments
			Total ($)	Unit 1 ($)	Unit 2 ($)	
931.	Field Office Expenses	1,490,000	2,235,000	1,490,000	745,000	Unit 2 costs reflect the greater scope of work and longer schedule required for a two unit station vs. a single unit station, based upon UE&C experience.
932.	Field Job Supervision	15,440,000	25,700,000	15,500,000	10,200,000	
933.	Field QA/QC	425,000	680,000	425,000	255,000	
934.	Plant Startup & Test	710,000	1,136,000	710,000	426,000	Unit 2 costs reflect the greater scope of work and longer schedule required for a two unit station vs. a single unit station, based upon UE&C experience
9.	TOTAL INDIRECT COSTS	100,020,000	155,561,560	100,240,000	55,321,560	Total Indirect Costs
	TOTAL BASE COST	506,162,627	893,716,147	508,163,366	385,552,781	Total Base Cost

(a) 1 x 486 MWe High-Sulfur Coal-Fired Power Generating Station
(b) 2 x 486 MWe High-Sulfur Coal Fired Power Generating Station

FIGURE 6.1

PLOT PLAN
TWIN 486 MWe HSC FPGS
MIDDLETOWN HYPOTHETICAL SITE

DRAWING NUMBER 7553.001-HSC5-01A

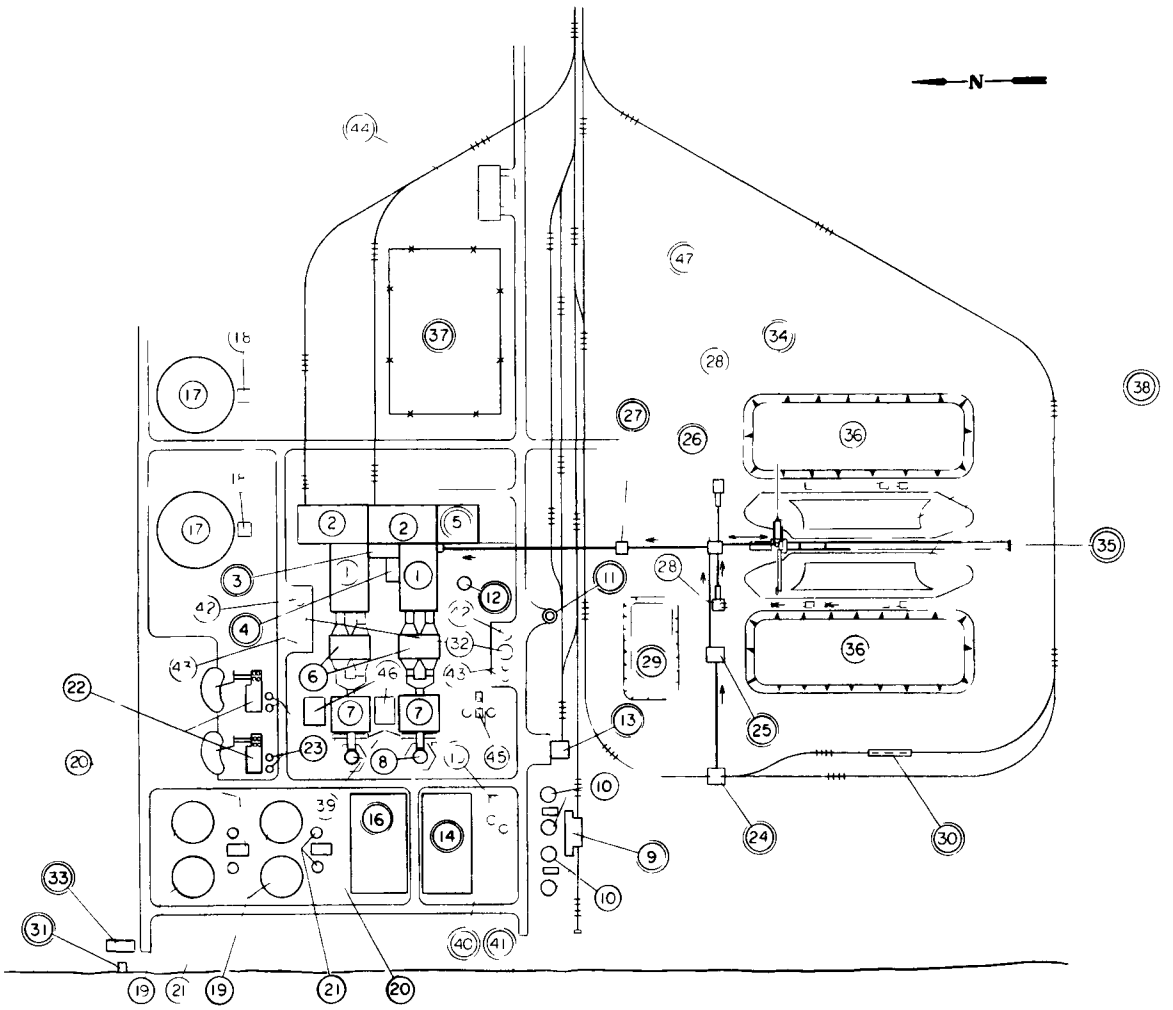
PLANT NOMENCLATURE

1 STEAM GENERATOR BUILDING
2 TURBINE BUILDING
3 CONTROL BUILDING
4 AUXILIARY BOILER AND DIESEL GENERATOR BUILDING
5 ADMINISTRATION/SERVICE BUILDING
6 PRECIPITATOR
7 FGD ABSORBER AREA
8 STACK
9 LIME UNLOADING BUILDING
10 LIME FEED PREPARATION/STORAGE FACILITY
11 FUEL OIL STORAGE TANK
12 CONDENSATE STORAGE TANK
13 LOCOMOTIVE REPAIR SHOP
14 WASTE WATER TREATMENT AREA
15 PROCESS AND SEAL WATER PUMPHOUSE
16 TEMPORARY FGD WASTE STORAGE AREA
17 COOLING TOWER
18 CIRCULATING WATER PUMPHOUSE
19 THICKENERS
20 THICKENER EQUIPMENT BUILDING
21 OVERFLOW TANKS
22 SLUDGE STABILIZATION BUILDING AND STACKOUT AREA
23 UNDERFLOW SURGE TANK
24 ROTARY CAR DUMPER
25 BREAKER HOUSE
26 STACKER RECLAIMER TRANSFER TOWER
27 CRUSHER HOUSE
28 RECLAIM TRANSFER TUNNEL
29 COAL PILE RUNOFF BASIN
30 COAL CAR THAW SHED
31 *INTAKE STRUCTURE*
32 RECIRCULATION TANK
33 MAKE UP WATER PRETREATMENT BUILDING
34 BUCKET WHEEL STACKER/RECLAIMER
35 STACKER/RECLAIMER
36 DEAD STORAGE COAL PILE
37 SWITCHYARD
38 ACTIVE STORAGE COAL PILE
39 REHEAT FANS (FUTURE)
40 PROCESS WATER SURGE TANK
41 SEAL WATER TANK
42 SETTLING TANK
43 DEWATERING TANKS
44 WAREHOUSE
45 LIME FEED SLURRY BUILDING
46 ABSORBER AREA ELECTRICAL/CONTROL BUILDING
47 RAILROAD

KEY

◯ COMMON TO UNITS 1 & 2

◯ REQUIRED FOR EACH UNIT



REV NO	DATE	DESCRIPTION	ENGR	SUP ENG
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STATE REG		NO		

PLOT PLAN
TWIN 486 MWe HSC NPGS
MIDDLETOWN HYPOTHETICAL SITE

united engineers & constructors inc.

7553001 HSCS-01A

SECTION 7

7.0 CAPITAL COST ESTIMATES FOR NUCLEAR POWER PLANTS FOR THE 1990's

7.1 INTRODUCTION

The EEDB Phase VI Update (1983) developed nuclear power plant base construction costs that were representative of the median industry cost experience for the 1980's. These costs are presented in Sections 2 and 5 and analyzed in Sections 3, 4 and 5 of this report. Various field surveys, conducted in parallel with the Phase VI Update, provided benchmark data to the Update effort. Table 4-3 provides a summary of the survey information that was used to assure that the Update costs would be representative of current industry median cost experience.

During the EEDB Phase V Update (1982) and continuing in the Phase VI Update, nuclear power plant base construction costs were found to be rising at a rate that was more than double the inflation rate. The factors driving these costs were identified and discussed in the Phase V Update Report[2] and summarized in the Executive Summary of that report (refer to Apppendix C). It was also found that the highest and lowest reported costs had diverged to a near 2:1 ratio for the large single unit PWR units of Table 4-3 and to a near 3:1 ratio for all nuclear power plants under construction, including several projects facing cancellation because of high costs. Additionally, the most rapid cost increases were being reported at the high end of the industry cost range. Because of these trends, the median industry cost was rising rapidly also, masking the better experience at the low end of the cost range.

In order to provide cost estimates that were more representative of commercially viable systems that may be anticipated for the 1990's, modifications were made to the Phase VI Update nuclear power plant (PWR, BWR and LMFBR) estimates. Projected costs were developed that were based on current best industry cost experience and that reflected the postulated effects of proposed improved construction practices and nuclear regulatory and licensing reforms. In particular, the projected costs were freed from the effects of proliferation of regulations, codes and standards; owner/designer overreaction to these regulations, codes and standards; rework caused by field interferences, constantly changing designs and inadequate engineering-to-construction lead times; extreme precision in analyses, coupled with inflexible design and construction quality assurance procedures; management preoccupation with I&E (regulatory inspection and enforcement) site visits; and low worker morale, caused by all of the above, as cited in Section 3.2.2.

7.2 GROUND RULES AND ASSUMPTIONS

The development of the cost estimates for nuclear power plants for the 1990's was subject to the EEDB ground rules and assumptions given in the EEDB Program Reference Book.[6] These are the same ground rules and assumptions under which the Phase VI Update and all previous updates have been performed.

The EEDB ground rules and assumptions were supplemented with the following additional ground rules and assumptions:

- Regulatory reform, such as that proposed in the House of Representatives Bill, H.R. 2511, and improved design/construction practice were assumed to be promulgated and implemented.

- Field survey data utilized in the Phase V (1982) and Phase VI Updates was used as a basis for establishing best industry cost/labor experience.

- The cost and regulation date was the same as that of the Phase VI Update; January 1, 1983.

- Equipment and commodity costs, craft labor rates and professional salaries were taken as the same values for the 1980's and 1990's plants, because the estimates for both sets of plants were developed in January 1, 1983 constant dollars.

- The construction schedule for the lead nuclear power plant, the PWR, was reduced from 98 to 90 months, in accordance with independent estimates that have concluded that the time span from construction permit application to commercial operation might be reduced to 90 months under proposed regulatory reforms.

- Fossil power plant unit installation hours were assumed for nonsafety-related structures/systems.

- Best nuclear power plant unit installation hours were assumed for safety-related structures/systems.

7.3 COST ESTIMATE METHODOLOGY

The base cost estimate for the 1990's plants was performed on the EEDB lead reference nuclear power plant, the PWR. The results of this effort were then used as a basis to develop estimates for the BWR and the LMFBR.

The PWR for the 1990's technical/cost data model was generated by making the following changes (listed in their decreasing order of cost impact) to the PWR (for the 1980's) technical/cost data model from the Phase VI Update:

1. Field job supervision manhours were reduced to 20 percent of those for the 1980's PWR, based on the field survey data. Nevertheless, field job supervision for a nuclear power plant was still 165 percent of that required for the HS8 fossil power plant (on the basis of the ratio of supervision hours per site labor hour).

2. Commodity (e.g., concrete, structural steel, piping, wiring) installation hours were made equal to those experienced in fossil power plant construction for the non-

nuclear/non-safety-related areas of the plant. Higher manhours per unit of commodity, based on the field survey data, were used for the nuclear/safety-related portions of the plant. These unit hours were higher than for similar fossil power plant work because they accommodated the rigorous procedure and documentation requirements of a nuclear power plant. However, they were lower than similar EEDB-Phase VI Update PWR unit hours because they were based on field survey best experience data instead of median experience data.

3. Home office engineering and support service manhours were reduced to 55 percent of those for the 1980's PWR based on the field survey data.

4. Quantities of commodities were reduced based on the field survey data.

5. Indirect costs, other than those itemized in changes 1, 3, 6 and 7 of this list, were reduced based on the overall reductions in labor and base construction costs. Specifically, these costs included tools and equipment, quality assurance and quality control, surveying, and plant start-up and test.

6. Temporary construction services were reduced based on experience and judgement. Judgement was strongly influenced by averaging these costs for the PWR for the 1980's and those developed for the EEDB Phase V Update.

7. Payroll insurance and taxes were decreased in direct proportion to the decrease in the site labor cost.

8. Manhours to install equipment and instruments for major direct cost accounts, where information was not available from the field survey, were decreased by a nominal 15 percent. This percentage was deduced from an analysis of the impact of the field survey installation manhour data on overall cost changes.

These changes were made at the PWR nine-digit code-of-accounts level of detail across the entire spectrum of up to 400 systems, 1250 mini-specifications and 10,000 data lines of technical/cost information. The methodology was developed to integrate the best cost experience from the field survey data with the detail of the 1980's PWR technical/cost data model. Labor costs (craft, engineering and field supervision) were emphasized because of the impact that they have had on driving nuclear power plant costs upward. This effect is dramatically portrayed on Figures 3.1 and 3.3. The goals selected for the labor content for the 1990's PWR were based on the information given in Table 4-3. In order to introduce conservatism into the estimate, the manhour levels for the lowest cost plant were discarded.

The methodology described above, and implemented in accordance with the ground rules given in Section 7.2, provided a logical and organized approach to determine the impact that current best cost experience, regulatory reform and improved construction practice may have on a plant for the 1980's that is anticipated to be designed and constructed as a plant for the 1990's. No attempt was made to correlate the various cost improvements with specific regulatory reforms or improved construction practices. The Electric Power Research Institute and others are currently studying the ramifications of these interrelationships. In this exercise, the assumption was made that the proposed improvements could be made because they had already been achieved by the owners of the lower cost plants. The objective of the effort was to determine the magnitude of the potential cost reductions.

7.4 TECHNICAL SUMMARY

The technical design features of the nuclear power plants for the 1990's were essentially the same as those of the 1980's and are listed in Table 2-1. Advanced reactor designs for improving safety and reducing costs were not incorporated into the 1990's technical data models. Such incorporation, however, is an important cost reduction option for future consideration.

The decreases in quantities of commodities and labor, which were based on the field survey data, implied differences in design philosophy and construction practice between the plants of the 1980's and those of the 1990's. No effort was made to identify those changes in philosophy and practice that would be necessary to decrease these quantities. Rather, the best experience field survey data were taken at face value, and the decreased quantities were assumed to be achievable. It was anticipated that regulatory reform and improved construction practices would reduce uncertainty over what was required by the regulator, foster early settlement of licensing issues, produce better communication between regulator and regulated, promote enlightened approaches to flexibility and practicality in the area of analyses and quality assurance, encourage longer design/construction lead times and lead to better management and control of projects. It was assumed that these improvements would greatly reduce the incidence of reengineering, redesign, reconstruction and schedule extensions common to current industry nuclear power plant experience, but this was not confirmed.

7.5 CAPITAL COSTS

7.5.1 Capital Cost Summary

Capital costs were prepared for the plants for the 1990's as "overnight" base construction costs, which were the sum of the direct and indirect costs. Direct costs comprised equipment and commodity costs and the costs of necessary site material and labor for installation of the equipment and commodities. Indirect costs included the costs of construction services, engineering, engineering support, construction management, field supervision, quality assurance, insurance and taxes, and other expenses such as payroll overhead and fees . EEDB base construction costs included only those cost elements described in the EEDB Program Reference Book.[6] They specifically excluded

owner's costs, contingencies, escalation and allowance for funds used during construction. Direct, indirect and base construction costs are summarized in Table 7-1 for the nuclear power plant data models for the 1990's.

Tables 7-2 and 7-3 also summarize the same data for the technical/cost data models for the 1990's, except that the capital costs have been normalized to the identical electrical or thermal capacities, respectively. The normalization process is discussed in Section 6 of the Program Reference Book. The net electrical capacity chosen for this process is that of the EEDB PWR, so that capital costs of the other technical data models can be compared to this most frequently chosen industry cost base. The nominal thermal capacity chosen for the normalization process is the maximum licensable nuclear power plant thermal rating of 3800 MWt, so that costs may also be compared on the basis of maximum licensable capacity.

Costs given in this section are representative of the PWR, BWR and LMFBR nuclear power plants for the 1990's and are presented as January 1, 1983 constant dollars. Tables 7-1, 7-2 and 7-3 are directly comparable to Tables 2-3, 2-4 and 2-5 respectively, which give power plant costs for the 1980's.

7.5.2 Detailed Capital Costs

Results of the capital cost estimate for nuclear power plants for the 1990's are presented for each technical data model at the two-digit and three-digit code-of-accounts level of detail in Tables 7-4 through 7-6 as indicated below. The first sheet of each table is a cost and manhours tabulation at the two-digit code-of-accounts (plant account) level of detail. The following four sheets comprise the cost and manhours tabulation at the three-digit code-of-accounts (structure/system account) level of detail. Additional detail for the PWR, BWR and LMFBR to the nine-digit code-of-accounts (commodity/component account) level of detail, is available in the EEDB Backup Data File as defined in the Program Reference Book.[6]

Nuclear Power Plant Data Models for the 1990's	PWR	BWR	LMFBR
Table Number	7-4	7-5	7-6

7.6 COST COMPARISONS OF PLANTS FOR THE 1990'S WITH PLANTS FOR THE 1980'S

7.6.1 The PWR, BWR and LMFBR Cost Comparisons

The estimate of nuclear power plant costs for the 1990's were compared with the Phase VI Update estimate of their costs for the 1980's. The results of the comparison are given in Table 7-7. The comparison was made in terms of 1983 constant dollars, constant dollars per kilowatt, and manhours per kilowatt. The percent decrease in costs from a 1980's NPGS (Nuclear Power Generating Station) to a 1990's NPGS was also established. A graphical presentation of this comparison is given in terms of dollars per kilowatt in Figure 7.1.

The numbers indicated that the decrease in costs for the 1990's plants was relatively uniform for the PWR, BWR and LMFBR. In all cases, the decrease in indirect costs was about twice the decrease in direct costs and the craft manhours were nearly cut in half. However, the LMFBR direct costs decreased by a lower percentage than the direct costs for the PWR and BWR. This occurred because the LMFBR nuclear steam supply system (NSSS) cost, which did not change on a constant dollar basis in this comparison, typically represented a larger percentage of its direct costs. The cost of the LMFBR NSSS was 28 percent of the LMFBR total direct costs, while the cost of the PWR NSSS was only 14 percent of the PWR total direct costs.

Since the PWR is the lead nuclear power plant data model in the EEDB and since the BWR and LMFBR cost decreases closely followed those of the PWR, the cost trend discussions in the following sections will focus on the PWR. Generally, the same relationships that hold for the EEDB PWR will also apply to the other two nuclear power plant data models.

7.6.2 Cost Comparison for the 1980's PWR, the 1990's PWR and the HS8

Base construction costs for the 1980's PWR, the 1990's PWR and the HS8 (which was a power plant for the 1980's) were compared and the results are given in Figure 7.2. Because the PWR and the HS8 have different capacities, this comparison was done on a dollar per kilowatt-electrical ($/kWe) basis.

The base construction costs were subdivided into labor and factory-equipment-plus-site-material because manhours and commodities were thought to be the principal nuclear power plant cost drivers. It was apparent, however, that on a dollar per kilowatt-electric basis, the labor costs were the primary drivers of the differences in the base construction costs. Labor costs for the 1980's PWR were 375 percent of those of the HS8, while labor costs for the 1990's PWR were only 180 percent of those of the HS8.

Figures 7.3 and 7.4, respectively, subdivide the factory-equipment-plus-site-material costs and labor costs of Figure 7.2 into their individual major components. Figure 7.3 emphasizes the fact that the equipment/material costs for the PWR for the 1990's are almost identical in total to those of the HS8. The major differences were the greater cost of construction services (CS) and the steam supply system (NSSS/FSSS) for the 1990's PWR which balanced the cost of the SO_2 removal equipment (SR) for the HS8. Smaller differences were found in the higher 1990's PWR costs for the turbine-generator (TG), piping (P), electrical/I&C (E), and other structural (S) categories which were balanced by greater HS8 costs for the mechanical (M) and structural support (SS) categories.

Table 7-8 identifies the sub-categories of each of the nine equipment/material major cost components and the costs of each of these sub-categories. Examination of this numerical data can provide many useful insights into the cost relationships of the three power plants. For example, examination of the mechanical (M) sub-categories dollar per kilowatt-electric revealed that most of the cost difference between the higher mechanical cost HS8 and each of the two PWR's was contributed by the HS8 coal and ash handling systems. The

1990's and 1980's PWR mechanical costs were nearly the same because the PWR's were technically identical in this category. The PWR pumps, condensers, cooling towers and other costs were somewhat higher than those for the HS8 because the PWR thermal cycle was less efficient than that of the HS8. The special process and water treatment costs were about twice as high for the PWR as for the HS8 because of nuclear radiation/safety related requirements.

By subdividing labor costs into eight categories, it was possible to identify those which caused major cost differences among the technical data models. These differences are illustrated graphically in Figure 7.4. The labor cost categories given in Figure 7.4 and Table 7-9 include the cost elements listed below.

- Structural craft labor costs (SC) are labor costs for construction of structures, buildings and other civil works. These are direct costs.

- Mechanical craft labor costs (MC) are labor costs for installation of nuclear plant, mechanical plant, miscellaneous plant and main condenser heat rejection systems and equipment. These are direct costs.

- Electrical/Instrumentation and Control craft labor costs (EC) are labor costs for installation of instrumentation, control and electrical systems and equipment. These are direct costs.

- Construction services costs (CS) are costs for temporary construction facilities and their associated erection craft labor, construction tools and equipment and their associated maintenance and storage craft labor and services, craft labor for survey teams, time for construction training meetings and field office expenses. These are indirect costs.

- Engineering costs (E) include salaries and expenses for engineering and engineering support personnel and services. These are indirect costs.

- Field supervision costs (FS) include salaries and expenses for non-manual field supervision personnel and services. These are indirect costs.

- Other costs (O) include salaries and expenses for home office quality assurance (NPGS only) and construction management personnel, and field office quality assurance (NPGS only)/ quality control and start-up and test personnel and services. These are indirect costs.

- Insurance and Taxes (I&T) include payroll insurance and taxes, permits, other insurance and local taxes. These are indirect costs.

Because the three elements of the direct labor costs for the 1980's PWR (SC, MC and EC) were reduced by 45 percent for the 1990's PWR, the dollars per kilowatt-electric for direct labor were only nine percent higher for the 1990's PWR than for the HS8. The PWR for the 1990's had higher structural labor costs than the HS8 primarily because more densely reinforced concrete per kWe was required for the PWR. The HS8 had higher mechanical labor costs than the PWR for the 1990's because there was more heavy equipment (coal handling, ash handling, and electrostatic precipitating equipment) to be erected in the HS8 boiler plant than in the PWR reactor plant. In addition, boiler erection required considerably more manhours than reactor erection. Table 7-9 identifies each of the sub-categories of the four major labor cost components and the costs for each of the sub-categories. As with Table 7-8, examination of the numerical data can provide useful insights into the labor driven cost relationships of the two PWR's and the HS8.

The five elements of indirect labor cost for the 1980's PWR tabulated in Figure 3.3 (CS, E, FS, O and I&T) were reduced by 52 percent for the 1990's PWR. Nevertheless, the 1990's PWR costs for these accounts exceeded those for the HS8 by 80 percent. The 1980's PWR costs for these accounts were almost four times as high as those for the HS8. The higher PWR indirect costs were caused by the field experience factors listed below. Although these factors operated on both the 1980's PWR and the 1990's PWR, they were more predominant for the 1980's PWR because of the regulatory and construction practices cited in the introduction to this section.

- The nuclear power plants had longer construction times and more support facilities than the fossil power plant. Therefore, construction service (CS) labor cost was higher.

- Engineering (E) was more complex and less standard for the nuclear power plants than for the fossil power plant. Even though reforms were expected to reduce unnecessary documentation and rework, engineering in dollars per kilowatt-electric was almost five times as much for the 1990's PWR as for the HS8.

- Field job supervision (FS) on a nuclear power plant required more time than on a fossil power plant because the standards were more rigorous, construction was more complex, and more site labor per kWe needed to be supervised. Even with anticipated improvements, the PWR for the 1990's had 2.4 times as many dollars per kilowatt-electric for job supervision as the HS8.

- Other (O) indirect manhour costs covered quality assurance and control at the home office and in the field, home office construction management, field office services, and start-up and testing services. Since the fossil power plant requirements for these items were small, the fact that the PWR for the 1990's costs in this area exceeded those of the HS8 (in dollars per kilowatt-electric) by a factor of five did not lead to a very large cost difference.

- Insurance and taxes (I&T) were essentially a direct function of base labor costs and covered social security, unemployment, workmen's compensation, personal liability/ disability insurance, and builder's all risk insurance. Therefore, as the PWR/HS8 labor hours ratio rose, the PWR/HS8 ratio for this category rose proportionately.

7.6.3 Cost Decreases Between the PWR for the 1980's and the PWR for the 1990's

Implementing the methodology described in Section 7.3 on the Phase VI Update PWR (for the 1980's), in accordance with the ground rules given in Section 7.2, yielded a base construction cost reduction for the PWR for the 1990's of $\$777 \times 10^6$ or \$682/kWe. Table 7-10 identifies the four areas in which this cost reduction was achieved and the magnitude of the cost reduction in each area. Tables 7-11 through 7-14 identify specific and important cost reduction sources for each of the areas listed in Table 7-10.

Indirect Costs

The most important cost reduction area was the Indirect Costs listed in Table 7-11. Major reductions were made in the engineering and field service manhours to conform to the field survey best experience. Almost half of the total cost reduction came from these two items, with the field supervision reduction amounting to almost one-third of the total cost reduction.

For the nuclear power plants covered in Table 4-3, the field surveys indicated a range of field supervision manhours per kilowatt of 9:1. Correlations were found between high levels of field supervision and:

- overlapping or duplication of field supervision functions among utilities and their agents (architect-engineers, construction managers, contractors);
- a high number of engineering change notices;
- a high incidence of field interferences;
- high levels of craft labor; and
- major schedule extensions.

It was assumed that regulatory reform and improved construction practices would permit areas such as these to be controlled to the extent that use of the lower end of the experience range of field supervision hours in the 1990's PWR cost estimate was justifiable.

A range of engineering manhours per kilowatt of 7:1 was indicated by the field survey for nuclear power plants covered by Table 4-3. Correlations were found between high levels of engineering and:

- frequent iteration of licensing questions;
- casual or infrequent communication with the regulators;
- high numbers of field change requests generated by field interferences and other problems;
- extensive checking of complex safety-related structural and piping analyses and documentation;
- preoccupation with safety-related materials/equipment qualification and documentation; and
- short design/construction lead times.

It was assumed that regulatory reform and improved construction practice would also permit areas such as these to be controlled to the extent that use of the lower end of the experience range of engineering hours in the 1990's PWR cost estimate was justifiable.

The reduction in temporary construction facilities was based on there being fewer job supervision personnel, lower craft manpower requirements, and decreased facilities in the 1990's PWR than in the PWR for the 1980's. Payroll insurance and taxes were decreased in direct proportion to the 1990's PWR decrease in the base labor cost. The shortened construction schedule for the 1990's PWR reduced the costs for guards, janitorial services, temporary facilities, home office construction management, and field office expenses.

Other indirect cost reductions involving tools and major equipment, home office and field Quality Assurance/Control, and plant start-up and testing were also made. These cost reductions were based on the reduction in work force and quantities of commodities for the 1990's PWR and the assumption that regulatory reform and improved construction practice would lead to greater efficiencies in these areas.

Commodity Installation (Labor) Costs

The second largest cost reduction area was the craft labor for installing the 1990's PWR commodities itemized in Table 7-12. It was significant that half of this cost reduction was related to piping installation, because that activity had been plagued with interferences, quality assurance deficiencies and rework in actual practice.

The reductions in cost were directly related to reductions in labor because the costs per manhour were identical for the two data models. The reduction in manhours was caused by reductions in the manhours-per-unit-of-commodity factors. Manhours-per-unit-of-commodity were reduced for the non/nuclear, non/safety-related systems and structures to the level of typical values for fossil power generating stations. This action was established as a ground rule because there is every reason to believe that such duplication of experience is achievable.

In the nuclear/safety-related structures and systems, manhours per unit of commodity were reduced to reasonable levels (higher than fossil power plant typical values) that were based on best experience data accumulated by the field surveys. It was assumed that these levels would be achievable if the necessary regulatory reform was enacted and improved construction practices were implemented. The development of shorter schedules coupled with the incorporation of more flexible construction control procedures and reduction of rework caused by regulatory changes, design changes and interferences could cause significant reductions in craft manhours.

The additional impact of the reduction of commodities on decreases in craft labor hours is shown in Table 7-15. This table summarizes the total decreases in commodity quantity, manhours and labor costs resulting from the above installation labor changes and the quantity changes which are discussed below. These data are listed in their order of economic importance. The percentage cost decrease was almost always less than the percentage manhour decrease and more than the percentage quantity decrease. This resulted where the cost of the commodity was a smaller percentage of the installed cost than the cost of the labor to install it. It may be seen from Table 7-15 that the commodity reduction made a significant contribution to the labor reduction. However, a comparison of Tables 7-12 and 7-13 shows that the cost reduction caused by the decreases in manhours per unit of commodity is 2.5 times the cost reduction caused by the decreases in commodities (decreases in manhours per unit of commodity coupled with decreases in quantities of commodities).

Commodity Installed (Labor plus Material) Costs

The cost reductions achieved by decreases in commodities are itemized in Table 7-13. The commodity decreases were based on the best experience field survey data. The magnitude of each major quantity reduction is shown in Table 7-15. The quantity decreases reduced costs in two ways: directly in conjunction with commodity costs; and indirectly in conjunction with a reduction in installation manhours. It was assumed that regulatory reform and improved construction practice would create the stability necessary to permit a gradual reduction in commodities over time, through design innovation and refinement. There was a clear indication from the field data, however, that the best experience plants currently contained proportionately fewer commodities and manhours than the plants with poor experience.

Other Installation (Labor) Costs

Other cost reductions were achieved through the variety of miscellaneous craft labor decreases itemized in Table 7-14. All of these reductions were based on experience and judgement because they were indirectly caused by other changes discussed above. For example, decreases in structural commodities (i.e., smaller buildings and shorter distances) and manhours per foot of cable implied reductions in the manhours required to install the building lighting and service power systems. Consequently, a small reduction in craft manhours was estimated for these systems. Similarly, other changes were estimated for the areas noted in Table 7-14.

7.7 POTENTIAL REDUCTIONS IN THE COST ESTIMATES FOR THE 1990'S PLANTS

The 1990's PWR cost estimate described in the previous sections is conservative because it only reflects near best industry experience, a seven and a half year construction schedule and older conventional technology. Additional cost reductions may be possible through improvements in the best cost experience, implementation of shorter schedules or utilization of advanced reactor concepts. As a minimum, any or all of these potential reductions may need to be incorporated to offset possible failures to meet the cost reduction expectations in all aspects of the 1990's PWR estimate.

Regulatory reform remained a congressional initiative and identification of needed improved construction practices was still being studied at the time the cost estimates were prepared for nuclear power plants for the 1990's. Consequently, the final form that regulatory reform and improved construction practice would take and the potential impact that they would have were uncertain. This uncertainty led to a conservative approach to the estimate that utilized near best experience rather than lowest reported costs, commodities and manhours, particularly in the area of the craft, engineering and field supervision manhours.

It is expected that a better understanding of the possible changes to regulation and construction practice will soon emerge. When this occurs, specific regulation, and technical and management improvements may be identified that will permit duplication or improvement of commodity and labor content of the current best experience plants. A better understanding of the means by which these objectives may be reached is expected to reveal potential reductions in the estimated cost of the nuclear power plants of the 1990's.

Construction schedules have a major impact on the cost sensitive area of construction facilities and labor, particularly installation and construction service labor. The magnitude of certain cost elements, such as guard, stores and janitorial services, and temporary facilities and services, such as temporary offices, water and power, are proportional to the length of the schedule. Other cost elements, such as craft labor, job supervision and quality control and inspection services, are sensitive to extended schedules relative to the efficiency with which the services are utilized and managed. Regulatory reform coupled with improved construction procedures may have the potential of reducing schedules further than the eight months assumed for the 1990's plants cost estimate. In this regard, it should be noted that other countries have consistently achieved nuclear power plant construction schedules that are less than 90 months; however, their average construction times are rising. A better understanding of the potential for schedule reduction may also lead to reductions in the 1990's nuclear power plant cost estimate.

During the period when the 1990's plant cost estimates were made, a number of advanced reactor designs were being studied and developed. Insufficient information was available, however, to project these advanced concepts into the EEDB base technical/cost data models. The objective of the advanced designs is generally to improve safety and reduce cost. The nuclear power industry has accumulated over 25 years of commercial nuclear power plant

design, construction and operating experience for over 100 units. It is likely that such a base can successfully support a new generation of advanced concepts that are safer and cheaper than their predecessors. Inclusion of an advanced concept into the 1990's plant cost estimate has the potential for reducing the estimated costs of the nuclear power plants for the 1990's.

Incorporation of all of the potential reductions discussed above in the cost estimate of the nuclear power plants for the 1990's might reduce these estimates by an additional $50/kWe to $100/kWe.

Effective Date 1/1/83

TABLE 7-1

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
CAPITAL COST UPDATE SUMMARY
PLANTS FOR THE 1990's
($1983 x 10^6)[a]

Model	Nuclear Plant Data Models for the 1990's			Comparison Plant Data Models	
	PWR	BWR	LMFBR[b]	HS8	HS5
MWt	3412	3578	3800	2210	1396
MWe	1139	1190	1457	791	486
Direct Cost	759	779	1221	534	406
Indirect Cost	480	492	642	129	100
Base Construction Cost	1239	1271	1863	663	506
$/kWe	1088	1068	1279	838	1041

(a) Data in January 1, 1983 Constant Dollars
(b) Reported costs do not include cost of the initial inventory of sodium

Effective Date 1/1/83

TABLE 7-2

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
NORMALIZED[a] CAPITAL COST UPDATE SUMMARY
PLANTS FOR THE 1990's
($1983 x 10^6)[b]

	Nuclear Plant Data Models for the 1990's			Comparison Plant Data Model(c)
Model	PWR	BWR	LMFBR(d)	HS8
MWt	3412	3425	2971	3182
MWe	1139	1139	1139	1139
Direct Cost	759	765	1088	725
Indirect Cost	480	483	572	175
Base Construction Cost	1239	1248	1660	900
$/kWe	1088	1096	1457	790
$/kWe / PWR $/kWe	1.00	1.01	1.34	0.73

(a) Normalized to a plant size providing 1139 MWe (net)
(b) Data in January 1, 1983 Constant Dollars
(c) Normalization not Applicable to HS5
(d) Reported costs do not include cost of the initial inventory of sodium

Effective Date 1/1/83

TABLE 7-3

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE
NORMALIZED[a] CAPITAL COST UPDATE SUMMARY
PLANTS FOR THE 1990's
($1983 x 10^6)[b]

Model	Nuclear Plant Data Models for the 1990's			Comparison Plant Data Models[c]
	PWR	BWR	LMFBR[d]	HS8
MWt	3800	3800	3800	3800
MWe	1269	1264	1457	1360
Direct Cost	793	799	1221	842
Indirect Cost	502	505	642	203
Base Construction Cost	1295	1304	1863	1045
$/kWe	1020	1032	1279	768
$/kWe / PWR $/kWe	1.00	1.01	1.25	0.75

(a) Normalized to a plant size of 3800 MWt or its equivalent
(b) Data in January 1, 1983 Constant Dollars
(c) Normalization Not Applicable to HS5
(d) Reported costs do not include cost of the initial inventory of sodium

Effective Date 1/1/83

TABLE 7-4

ENERGY ECONOMIC DATA BASE - PHASE VI UPDATE

1139 MWe PRESSURIZED WATER REACTOR NPGS FOR THE 1990'S

CAPITAL COST ESTIMATE

PLANT CODE 184 | COST BASIS 01/83

UNITED ENGINEERS & CONSTRUCTORS INC
EEDB PHASE VI - PLANTS FOR THE 1990'S
1139 MWE PRESSURIZED WATER REACTOR

06/22/84

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
21 .	STRUCTURES + IMPROVEMENTS	10,149,508	5130578 MH	95,400,213	62,661,251	168,210,972
22 .	REACTOR PLANT EQUIPMENT	194,974,933	1940544 MH	39,138,281	13,877,998	247,991,212
23 .	TURBINE PLANT EQUIPMENT	156,127,694	1762173 MH	35,324,349	8,144,618	199,596,661
24 .	ELECTRIC PLANT EQUIPMENT	28,717,192	1275200 MH	25,222,472	13,208,368	67,148,032
25 .	MISCELLANEOUS PLANT EQUIPT	15,838,698	846675 MH	17,073,889	5,031,403	37,943,990
26	MAIN COND HEAT REJECT SYS	21,228,993	698764 MH	13,621,088	2,763,439	37,613,520
	TOTAL DIRECT COSTS	427,037,018	11653934 MH	225,780,292	105,687,077	758,504,387
91 .	CONSTRUCTION SERVICES	55,200,000	4760000 MH	91,600,000	58,000,000	204,800,000
92	HOME OFFICE ENGRG &SERVICE	177,400,000				177,400,000
93 .	FIELD OFFICE ENGRG&SERVICE	78,300,000	424000 MH	8,200,000	11,300,000	97,800,000
	TOTAL INDIRECT COSTS	310,900,000	5184000 MH	99,800,000	69,300,000	480,000,000
	TOTAL BASE COST	737,937,018	16837934 MH	325,580,292	174,987,077	1,238,504,387

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
211.	YARDWORK	327,366	670229 MH	11,181,162	8,779,426	20,287,954
212.	REACTOR CONTAINMENT BLDG	2,504,196	1748260 MH	33,333,440	21,308,319	57,145,955
213.	TURBINE ROOM + HEATER BAY	527,965	475308 MH	9,068,403	9,943,546	19,539,914
214.	SECURITY BUILDING	50,000	34307 MH	654,979	339,269	1,044,248
215.	PRIM AUX BLDG + TUNNELS	2,852,632	418878 MH	7,844,729	3,761,427	14,458,788
216.	WASTE PROCESS BUILDING	579,778	389843 MH	7,213,839	3,802,821	11,596,438
217.	FUEL STORAGE BLDG	934,564	170206 MH	3,193,452	2,906,400	7,034,416
218A.	CONTROL RM/D-G BUILDING	1,360,844	462359 MH	8,716,576	4,391,262	14,468,682
218B.	ADMINISTRATION+SERVICE BLG	803,412	147267 MH	2,791,926	2,085,583	5,680,921
218D.	FIRE PUMP HOUSE,INC FNDTNS	36,819	10574 MH	200,849	133,354	371,022
218E.	EMERGENCY FEED PUMP BLDG	21,409	72860 MH	1,357,333	623,574	2,002,316
218F.	MANWAY TUNNELS (RCA TUNLS)		24462 MH	450,925	197,944	648,869
218G.	ELEC. TUNNELS	4,160	1528 MH	30,501	14,309	48,970
218H.	NON-ESSEN. SWGR BLDG.	20,904	13807 MH	261,382	212,972	495,258
218J.	MN STEAM + FW PIPE ENC.	30,264	228782 MH	4,323,019	2,040,404	6,393,687
218K.	PIPE TUNNELS		12694 MH	231,690	99,746	331,436
218L.	TECHNICAL SUPPORT CENTER	50,000	13576 MH	252,981	152,512	455,493
218M.	HYDROGEN RECOMBINER STRUCT	4,102	5596 MH	102,572	59,637	166,311
218P.	CONTAIN EQ HATCH MSLE SHLD		8165 MH	149,342	41,275	190,617
218S.	HOLDING POND		6375 MH	116,097	51,440	167,537
218T.	ULTIMATE HEAT SINK STRUCT	41,093	193797 MH	3,518,992	1,467,332	5,027,417
218V.	CONTR RM EMG AIR INTK STR		9705 MH	162,678	68,699	231,377
218Z.	WASTE WATER TREATMENT BLDG		12000 MH	243,346	180,000	423,346
21 .	STRUCTURES + IMPROVEMENTS	10,149,508	5130578 MH	95,400,213	62,661,251	168,210,972

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
220A.	NUCLEAR STEAM SUPPLY(NSSS)	139,050,000				139,050,000
220B.	NSSS OPTIONS					
221.	REACTOR EQUIPMENT	770,964	162200 MH	3,252,719	3,288,479	7,312,162
222.	MAIN HEAT XFER XPORT SYS.	2,829,032	249446 MH	5,072,246	729,450	8,630,728
223.	SAFEGUARDS SYSTEM	7,039,854	195285 MH	3,956,894	863,730	11,860,478
224.	RADWASTE PROCESSING	10,413,066	180049 MH	3,637,408	772,871	14,823,345
225.	FUEL HANDLING + STORAGE	4,198,506	44701 MH	905,327	109,438	5,213,271
226.	OTHER REACTOR PLANT EQUIP	15,963,872	612763 MH	12,410,392	4,538,399	32,912,663
227.	RX INSTRUMENTATION+CONTROL	12,377,046	319600 MH	6,323,530	478,806	19,179,382
228.	REACTOR PLANT MISC ITEMS	2,332,593	176500 MH	3,579,765	3,096,825	9,009,183
22 .	REACTOR PLANT EQUIPMENT	194,974,933	1940544 MH	39,138,281	13,877,998	247,991,212

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
231.	TURBINE GENERATOR	109,946,388	326745 MH	6,500,921	1,256,298	117,703,607
233	CONDENSING SYSTEMS	19,250,216	354250 MH	7,146,910	1,460,623	27,857,749
234	FEED HEATING SYSTEM	14,344,499	287124 MH	5,820,523	579,981	20,745,003
235.	OTHER TURBINE PLANT EQUIP	10,853,433	405454 MH	8,210,541	1,192,068	20,256,042
236	INSTRUMENTATION + CONTROL	1,733,158	190600 MH	3,768,334	323,848	5,825,340
237	TURBINE PLANT MISC ITEMS		198000 MH	3,877,120	3,331,800	7,208,920
23 .	TURBINE PLANT EQUIPMENT	156,127,694	1762173 MH	35,324,349	8,144,618	199,596,661
241	SWITCHGEAR	10,033,856	24220 MH	478,124	49,298	10,561,278
242	STATION SERVICE EQUIPMENT	15,727,160	89402 MH	1,758,420	267,950	17,753,530
243	SWITCHBOARDS	1,382,728	14690 MH	290,246	121,659	1,794,633
244	PROTECTIVE EQUIPMENT		102650 MH	2,040,641	1,648,138	3,688,779
245.	ELECT STRUC +WIRING CONTNR		662790 MH	13,072,015	3,381,256	16,453,271
246	POWER & CONTROL WIRING	1,573,448	381448 MH	7,583,026	7,740,067	16,896,541
24 .	ELECTRIC PLANT EQUIPMENT	28,717,192	1275200 MH	25,222,472	13,208,368	67,148,032

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UNITED ENGINEERS & CONSTRUCTORS INC.
EFDB PHASE VI - PLANTS FOR THE 1990'S
1139 MWE PRESSURIZED WATER REACTOR

06/22/84

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
251.	TRANSPORTATION & LIFT EQPT	3,003,980	38900 MH	788,848	452,522	4,245,350
252.	AIR,WATER+STEAM SERVICE SY	7,194,030	550165 MH	11,140,097	3,991,251	22,325,378
253.	COMMUNICATIONS EQUIPMENT	1,948,800	159500 MH	3,170,796	533,660	5,653,256
254.	FURNISHINGS + FIXTURES	2,081,888	23110 MH	453,987	53,970	2,589,845
255.	WASTE WATER TREATMENT EQ	1,610,000	75000 MH	1,520,161		3,130,161
25 .	MISCELLANEOUS PLANT EQUIPT	15,838,698	846675 MH	17,073,889	5,031,403	37,943,990
261.	STRUCTURES	246,635	92029 MH	1,695,834	1,066,595	3,009,064
262.	MECHANICAL EQUIPMENT	20,982,358	606735 MH	11,925,254	1,696,844	34,604,456
26 .	MAIN COND HEAT REJECT SYS	21,228,993	698764 MH	13,621,088	2,763,439	37,613,520
	TOTAL DIRECT COSTS	427,037,018	11653934 MH	225,780,292	105,687,077	758,504,387

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
911.	TEMPORARY CONSTRUCTION FAC		4417000 MH	85,000,000	20,000,000	105,000,000
912.	CONSTRUCTION TOOLS & EQUIP		343000 MH	6,600,000	36,800,000	43,400,000
913.	PAYROLL INSURANCE & TAXES	55,200,000				55,200,000
914.	PERMITS,INS. & LOCAL TAXES				1,200,000	1,200,000
915.	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	55,200,000	4760000 MH	91,600,000	58,000,000	204,800,000
921.	HOME OFFICE SERVICES	168,200,000				168,200,000
922.	HOME OFFICE Q/A	5,200,000				5,200,000
923.	HOME OFFICE CONSTRCTN MGMT	4,000,000				4,000,000
92 .	HOME OFFICE ENGRG &SERVICE	177,400,000				177,400,000
931.	FIELD OFFICE EXPENSES		29000 MH	600,000	11,300,000	11,900,000
932.	FIELD JOB SUPERVISION	63,000,000	300000 MH	5,800,000		68,800,000
933.	FIELD QA/QC	5,300,000	95000 MH	1,800,000		7,100,000
934.	PLANT STARTUP & TEST	10,000,000				10,000,000
93 .	FIELD OFFICE ENGRG&SERVICE	78,300,000	424000 MH	8,200,000	11,300,000	97,800,000
	TOTAL INDIRECT COSTS	310,900,000	5184000 MH	99,800,000	69,300,000	480,000,000
	TOTAL BASE COST	737,937,018	16837934 MH	325,580,292	174,987,077	1,238,504,387

Effective Date 1/1/83

TABLE 7-5

ENERGY ECONOMIC DATA BASE - PHASE VI UPDATE

1190 MWe BOILING WATER REACTOR NPGS FOR THE 1990'S

CAPITAL COST ESTIMATE

PLANT CODE 210 | COST BASIS 01/83

UNITED ENGINEERS & CONSTRUCTORS INC.
EEDB PHASE VI - PLANTS FOR THE 1990'S
1190 MWE BOILING WATER REACTOR

06/26/84

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
21 .	STRUCTURES & IMPROVEMENTS	8,446,652	6173174 MH	114,643,824	77,468,175	200,558,651
22 .	REACTOR PLANT EQUIPMENT	176,424,775	1892303 MH	38,103,845	12,908,218	227,436,838
23 .	TURBINE PLANT EQUIPMENT	161,333,968	1825097 MH	36,588,954	8,440,308	206,363,230
24 .	ELECTRIC PLANT EQUIPMENT	30,346,587	1307815 MH	25,868,668	13,528,731	69,743,986
25 .	MISCELLANEOUS PLANT EQUIPT	15,113,235	848637 MH	17,115,883	4,949,858	37,178,976
26 .	MAIN COND HEAT REJECT SYS	21,642,289	708343 MH	13,807,768	2,814,173	38,264,230
	TOTAL DIRECT COSTS	413,307,506	12755369 MH	246,128,942	120,109,463	779,545,911
91 .	CONSTRUCTION SERVICES	58,800,000	4778000 MH	92,000,000	59,900,000	210,700,000
92 .	HOME OFFICE ENGRG.&SERVICE	177,400,000				177,400,000
93 .	FIELD OFFICE ENGRG&SERVICE	83,700,000	457000 MH	8,800,000	11,300,000	103,800,000
	TOTAL INDIRECT COSTS	319,900,000	5235000 MH	100,800,000	71,200,000	491,900,000
	TOTAL BASE COST	733,207,506	17990369 MH	346,928,942	191,309,463	1,271,445,911

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
211.	YARDWORK	327,366	708030 MH	11,810,444	9,113,485	21,251,295
212.	REACTOR CONTAINMENT BLDG	1,820,914	2093386 MH	39,933,467	29,769,096	71,523,477
213.	TURBINE ROOM + HEATER BAY	1,836,515	1162191 MH	21,594,605	15,493,231	38,924,351
214.	SECURITY BUILDING	50,000	34307 MH	654,979	339,269	1,044,248
215.	AUXILIARY BLDG + TUNNELS	429,652	621127 MH	11,640,092	5,869,508	17,939,252
216.	WASTE PROCESS BUILDING	508,154	311887 MH	5,791,824	3,133,575	9,433,553
217.	FUEL STORAGE BLDG	1,006,620	253735 MH	4,727,965	3,968,390	9,702,975
218A.	CONTROL RM/D-G BUILDING	1,534,481	556441 MH	10,486,806	5,259,595	17,280,882
218B.	ADMINISTRATION+SERVICE BLG	805,038	147307 MH	2,792,836	2,085,674	5,683,548
218D.	FIRE PUMP HOUSE,INC FNDTNS	36,819	10574 MH	200,849	133,354	371,022
218K.	PIPE TUNNELS		31743 MH	584,286	312,970	897,256
218L.	TECHNICAL SUPPORT CENTER	50,000	13576 MH	252,981	152,512	455,493
218S.	HOLDING POND		6375 MH	116,097	51,440	167,537
218T.	ULTIMATE HEAT SINK STRUCT	41,093	200790 MH	3,650,569	1,537,377	5,229,039
218V.	CONTR RM EMG AIR INTK STR		9705 MH	162,678	68,699	231,377
218Z.	WASTE WATER TREATMENT BLDG		12000 MH	243,346	180,000	423,346
21 .	STRUCTURES & IMPROVEMENTS	8,446,652	6173174 MH	114,643,824	77,468,175	200,558,651

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
220A.	NUCLEAR STEAM SUPPLY(NSSS)	130,800,000				130,800,000
220B.	NSSS OPTIONS					
221.	REACTOR EQUIPMENT	839,199	413600 MH	8,295,020	4,549,078	13,683,297
222.	MAIN HEAT XFER XPORT SYS.	616,376	113489 MH	2,315,665	228,551	3,160,592
223.	SAFEGUARDS SYSTEM	8,273,969	214799 MH	4,359,374	440,319	13,073,662
224.	RADWASTE PROCESSING	13,260,176	189557 MH	3,831,602	1,592,131	18,683,909
225.	FUEL HANDLING + STORAGE	2,024,864	45408 MH	919,542	107,899	3,052,305
226.	OTHER REACTOR EQUIP.	8,020,149	379150 MH	7,681,313	2,601,934	18,303,396
227.	INSTRUMENTATION + CONTROL	12,590,042	358100 MH	7,084,708	507,174	20,181,924
228.	REACTOR PLANT MISC ITEMS		178200 MH	3,616,621	2,881,132	6,497,753
22 .	REACTOR PLANT EQUIPMENT	176,424,775	1892303 MH	38,103,845	12,908,218	227,436,838
231.	TURBINE GENERATOR	111,636,132	345366 MH	6,879,480	1,288,708	119,804,320
233.	CONDENSING SYSTEMS	20,108,924	374980 MH	7,566,117	1,503,133	29,178,174
234.	FEED HEATING SYSTEM	13,860,050	282023 MH	5,715,973	569,559	20,145,582
235.	OTHER TURBINE PLANT EQUIP.	14,032,829	411178 MH	8,325,802	1,203,779	23,562,410
236.	INSTRUMENTATION + CONTROL	1,696,033	212300 MH	4,197,362	368,036	6,261,431
237.	TURBINE PLANT MISC ITEMS		199250 MH	3,904,220	3,507,093	7,411,313
23 .	TURBINE PLANT EQUIPMENT	161,333,968	1825097 MH	36,588,954	8,440,308	206,363,230

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
241.	SWITCHGEAR	9,796,731	26475 MH	522,642	53,750	10,373,123
242.	STATION SERVICE EQUIPMENT	17,661,528	104732 MH	2,066,295	318,395	20,046,218
243.	SWITCHBOARDS	1,382,728	14690 MH	290,246	121,602	1,794,576
244.	PROTECTIVE EQUIPMENT		102650 MH	2,040,641	1,648,138	3,688,779
245.	ELECT.STRUC +WIRING CONTNR		677743 MH	13,364,278	3,460,530	16,824,808
246.	POWER & CONTROL WIRING	1,505,600	381525 MH	7,584,566	7,926,316	17,016,482
24 .	ELECTRIC PLANT EQUIPMENT	30,346,587	1307815 MH	25,868,668	13,528,731	69,743,986
251.	TRANSPORTATION & LIFT EQPT	2,244,683	40000 MH	811,154	497,656	3,553,493
252.	AIR,WATER+STEAM SERVICE SY	7,227,864	551027 MH	11,159,785	3,864,572	22,252,221
253.	COMMUNICATIONS EQUIPMENT	1,948,800	159500 MH	3,170,796	533,660	5,653,256
254.	FURNISHINGS + FIXTURES	2,081,888	23110 MH	453,987	53,970	2,589,845
255.	WASTE WATER TREATMENT EQ	1,610,000	75000 MH	1,520,161		3,130,161
25 .	MISCELLANEOUS PLANT EQUIPT	15,113,235	848637 MH	17,115,883	4,949,858	37,178,976
261.	STRUCTURES	246,635	92967 MH	1,713,224	1,088,663	3,048,522
262.	MECHANICAL EQUIPMENT	21,395,654	615376 MH	12,094,544	1,725,510	35,215,708
26 .	MAIN COND HEAT REJECT SYS	21,642,289	708343 MH	13,807,768	2,814,173	38,264,230
	TOTAL DIRECT COSTS	413,307,506	12755369 MH	246,128,942	120,109,463	779,545,911

PLANT CODE 210 COST BASIS 01/83

UNITED ENGINEERS & CONSTRUCTORS INC.
FFDB PHASE VI - PLANTS FOR THE 1990'S
1190 MWE BOILING WATER REACTOR

06/26/84

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
911.	TEMPORARY CONSTRUCTION FAC		4424000 MH	85,200,000	20,100,000	105,300,000
912.	CONSTRUCTION TOOLS & EQUIP		354000 MH	6,800,000	38,500,000	45,300,000
913.	PAYROLL INSURANCE & TAXES	58,800,000				58,800,000
914.	PERMITS,INS. & LOCAL TAXES				1,300,000	1,300,000
915.	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	58,800,000	4778000 MH	92,000,000	59,900,000	210,700,000
921.	HOME OFFICE SERVICES	168,200,000				168,200,000
922.	HOME OFFICE Q/A	5,200,000				5,200,000
923.	HOME OFFICE CONSTRCTN MGMT	4,000,000				4,000,000
92 .	HOME OFFICE ENGRG.&SERVICE	177,400,000				177,400,000
931.	FIELD OFFICE EXPENSES		29000 MH	600,000	11,300,000	11,900,000
932.	FIELD JOB SUPERVISION	68,100,000	325000 MH	6,300,000		74,400,000
933.	FIELD QA/QC	5,600,000	103000 MH	1,900,000		7,500,000
934.	PLANT STARTUP & TEST	10,000,000				10,000,000
93 .	FIELD OFFICE ENGRG&SERVICE	83,700,000	457000 MH	8,800,000	11,300,000	103,800,000
	TOTAL INDIRECT COSTS	319,900,000	5235000 MH	100,800,000	71,200,000	491,900,000
	TOTAL BASE COST	733,207,506	17990369 MH	346,928,942	191,309,463	1,271,445,911

Effective Date 1/1/83

TABLE 7-6

ENERGY ECONOMIC DATA BASE - PHASE VI UPDATE

1457 MWe LIQUID METAL FAST BREEDER REACTOR NPGS FOR THE 1990'S

CAPITAL COST ESTIMATE

PLANT CO · 410 | COST BASIS 01/83

UNITED ENGINEERS & CONSTRUCTORS INC.
FFDR PHASE VI - PLANTS FOR THE 1990'S
1457 MWE LIQUID METAL FAST BREEDER REACTOR

06/26/84

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
21 .	STRUCTURES + IMPROVEMENTS	17,085,098	7593053 MH	141,770,939	98,586,337	257,442,374
22 .	REACTOR PLANT EQUIPMENT	462,875,245	3614029 MH	72,881,096	17,186,453	552,942,794
23 .	TURBINE PLANT EQUIPMENT	181,450,424	2040337 MH	40,877,336	8,441,784	230,769,544
24 .	ELECTRIC PLANT EQUIPMENT	31,303,104	1848282 MH	36,461,257	18,687,839	86,452,200
25 .	MISCELLANEOUS PLANT EQUIPT	26,013,799	1162317 MH	23,382,834	5,155,567	54,552,200
26 .	MAIN COND HEAT REJECT SYS	21,642,172	709941 MH	13,840,991	2,817,405	38,300,568
	TOTAL DIRECT COSTS	740,369,842	16967959 MH	329,214,453	150,875,385	1,220,459,680
91 .	CONSTRUCTION SERVICES	76,000,000	5639000 MH	108,500,000	82,000,000	266,500,000
92 .	HOME OFFICE ENGRG.&SERVICE	241,500,000				241,500,000
93 .	FIELD OFFICE ENGRG&SERVICE	107,600,000	583000 MH	11,300,000	15,400,000	134,300,000
	TOTAL INDIRECT COSTS	425,100,000	6222000 MH	119,800,000	97,400,000	642,300,000
	TOTAL BASE COST	1,165,469,842	23189959 MH	449,014,453	248,275,385	1,862,759,680

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
211.	YARDWORK	387,366	1002052 MH	16,698,425	11,664,719	28,750,510
212.	REACTOR CONTAINMENT BLDG	7,278,331	3268263 MH	62,531,650	43,528,739	113,338,720
213.	TURBINE ROOM + HEATER BAY	568,547	487500 MH	9,324,550	10,537,086	20,430,183
214.	SECURITY + TSC BUILDING	100,000	58348 MH	1,106,709	553,383	1,760,092
215.	REACTOR SERVICE BUILDING	3,252,000	659502 MH	12,376,195	6,660,324	22,288,519
216.	WASTE PROCESS BUILDING					
217.	FUEL STORAGE BLDG					
218A.	CONTROL RM/D-G BUILDING	2,318,969	577866 MH	10,905,241	5,775,858	19,000,068
218B.	ADMINISTRATION BUILDING	201,538	59555 MH	1,132,532	916,416	2,250,486
218C.	D/G COOLING TOWER		47694 MH	874,192	460,260	1,334,452
218D.	FIRE PUMP HOUSE,INC FNDTNS	36,819	10574 MH	200,849	133,354	371,022
218E.	STEAM GENERATOR BUILDING	968,376	489612 MH	9,263,622	7,189,214	17,421,212
218H.	NON-ESSEN. SWGR BLDG.	23,469	20153 MH	384,000	319,037	726,506
218I.	AUXILIARY BUILDINGS	731,644	423732 MH	7,844,922	4,748,508	13,325,074
218K.	PIPE TUNNELS		12694 MH	231,690	99,746	331,436
218N.	MAINTENANCE BUILDING	662,953	111109 MH	2,118,435	1,776,879	4,558,267
218R.	AUXILIARY BOILER BUILDING	174,337	35195 MH	673,808	626,388	1,474,533
218S.	HOLDING POND		6375 MH	116,097	51,440	167,537
218T.	ULTIMATE HEAT SINK STRUCT	117,499	95360 MH	1,749,154	687,910	2,554,563
218V.	CONTR RM EMG AIR INTK STR		9705 MH	162,678	68,699	231,377
218W.	AUX HEAT TRANS SYS BAYS	263,250	205764 MH	3,832,844	2,608,377	6,704,471
218Z.	WASTE WATER TREATMENT BLDG		12000 MH	243,346	180,000	423,346
21 .	STRUCTURES + IMPROVEMENTS	17,085,098	7593053 MH	141,770,939	98,586,337	257,442,374

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
220A.	NUCLEAR STEAM SUPPLY(NSSS)	431,000,000				431,000,000
220B.	NSSS OPTIONS					
221.	REACTOR EQUIPMENT	152,250	423000 MH	8,465,995	5,785,659	14,403,904
222.	MAIN HEAT XFER XPORT SYS.	5,822,642	1410420 MH	28,569,865	2,815,469	37,207,976
223.	SAFEGUARDS SYSTEM	32,781	61202 MH	1,239,054	123,907	1,395,742
224.	RADWASTE PROCESSING	9,246,130	189900 MH	3,834,187	615,890	13,696,207
225.	FUEL HANDLING	168,495	227810 MH	4,602,965	474,291	5,245,751
226.	OTHER REACTOR PLANT EQUIP	7,060,942	585797 MH	11,737,125	1,601,686	20,399,753
227.	RX INSTRUMENTATION+CONTROL	6,359,635	435900 MH	8,648,280	717,113	15,725,028
228.	REACTOR PLANT MISC ITEMS	3,032,370	280000 MH	5,783,625	5,052,438	13,868,433
22 .	REACTOR PLANT EQUIPMENT	462,875,245	3614029 MH	72,881,096	17,186,453	552,942,794
231.	TURBINE GENERATOR	123,877,733	403160 MH	8,019,252	1,568,510	133,465,495
233.	CONDENSING SYSTEMS	24,978,933	483831 MH	9,764,411	1,302,990	36,046,334
234.	FEED HEATING SYSTEM	17,805,404	270193 MH	5,482,893	547,150	23,835,447
235.	OTHER TURBINE PLANT EQUIP.	13,065,929	477353 MH	9,672,470	1,136,160	23,874,559
236.	INSTRUMENTATION + CONTROL	1,722,425	190600 MH	3,768,334	332,070	5,822,829
237.	TURBINE PLANT MISC ITEMS		215200 MH	4,169,976	3,554,904	7,724,880
23 .	TURBINE PLANT EQUIPMENT	181,450,424	2040337 MH	40,877,336	8,441,784	230,769,544

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
241.	SWITCHGEAR	11,615,171	34570 MH	682,445	69,729	12,367,345
242.	STATION SERVICE EQUIPMENT	16,492,941	95378 MH	1,873,607	295,222	18,661,770
243.	SWITCHBOARDS	1,413,668	14690 MH	290,246	126,681	1,830,595
244.	PROTECTIVE EQUIPMENT		102650 MH	2,040,641	1,709,600	3,750,241
245.	ELECT.STRUC +WIRING CONTNR		1073895 MH	21,095,797	5,685,180	26,780,977
246.	POWER & CONTROL WIRING	1,781,324	527099 MH	10,478,521	10,801,427	23,061,272
24 .	ELECTRIC PLANT EQUIPMENT	31,303,104	1848282 MH	36,461,257	18,687,839	86,452,200
251.	TRANSPORTATION & LIFT EQPT	4,838,500	48900 MH	991,636	72,801	5,902,937
252.	AIR,WATER+STEAM SERVICE SY	14,418,302	792927 MH	15,996,610	4,367,872	34,782,784
253.	COMMUNICATIONS EQUIPMENT	2,855,422	221500 MH	4,403,331	656,914	7,915,667
254.	FURNISHINGS + FIXTURES	2,291,575	23990 MH	471,096	57,980	2,820,651
255.	WASTE WATER TREATMENT EQ	1,610,000	75000 MH	1,520,161		3,130,161
25 .	MISCELLANEOUS PLANT EQUIPT	26,013,799	1162317 MH	23,382,834	5,155,567	54,552,200
261.	STRUCTURES	246,635	92985 MH	1,714,297	1,088,681	3,049,613
262.	MECHANICAL EQUIPMENT	21,395,537	616956 MH	12,126,694	1,728,724	35,250,955
26 .	MAIN COND HEAT REJECT SYS	21,642,172	709941 MH	13,840,991	2,817,405	38,300,568
	TOTAL DIRECT COSTS	740,369,842	16967959 MH	329,214,453	150,875,385	1,220,459,680

ACCT NO	ACCOUNT DESCRIPTION	FACTORY EQUIP. COSTS	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL COST	TOTAL COSTS
911.	TEMPORARY CONSTRUCTION FAC		5090000 MH	97,900,000	23,700,000	121,600,000
912.	CONSTRUCTION TOOLS & EQUIP		549000 MH	10,600,000	56,400,000	67,000,000
913.	PAYROLL INSURANCE & TAXES	76,000,000				76,000,000
914.	PERMITS,INS. & LOCAL TAXES				1,900,000	1,900,000
915.	TRANSPORTATION					
91 .	CONSTRUCTION SERVICES	76,000,000	5639000 MH	108,500,000	82,000,000	266,500,000
921.	HOME OFFICE SERVICES	229,000,000				229,000,000
922.	HOME OFFICE Q/A	7,100,000				7,100,000
923.	HOME OFFICE CONSTRCTN MGMT	5,400,000				5,400,000
92 .	HOME OFFICE ENGRG.&SERVICE	241,500,000				241,500,000
931.	FIELD OFFICE EXPENSES		40000 MH	800,000	15,400,000	16,200,000
932.	FIELD JOB SUPERVISION	86,600,000	412000 MH	8,000,000		94,600,000
933.	FIELD QA/QC	7,300,000	131000 MH	2,500,000		9,800,000
934.	PLANT STARTUP & TEST	13,700,000				13,700,000
93 .	FIELD OFFICE ENGRG&SERVICE	107,600,000	583000 MH	11,300,000	15,400,000	134,300,000
	TOTAL INDIRECT COSTS	425,100,000	6222000 MH	119,800,000	97,400,000	642,300,000
	TOTAL BASE COST	1,165,469,842	23189959 MH	449,014,453	248,275,385	1,862,759,680

TABLE 7-7

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

NPGS[a] COSTS FOR THE 1990's COMPARED WITH NPGS[a] COSTS FOR THE 1980's

Technical Model	PWR		BWR		LMFBR	
	1980's	1990's	1980's	1990's	1980's	1990's
1983 $ x 10^6[b]						
Direct Cost	996	759	1024	779	1551	1221
Indirect Cost	1020	480	1041	492	1364	642
Base Cost	2016	1239	2065	1271	2915	1863
1983 $/kWe[b]						
Direct Cost	874	666	860	655	1065	838
Indirect Cost	896	422	875	413	936	441
Base Cost	1770	1088	1735	1068	2001	1279
Manhours (MH)						
MH/kWe	26	15	26	15	28	16

Percent Decrease from 1980's Units to 1990's Units			
Direct Cost	24	24	21
Indirect Cost	53	53	53
Base Cost	39	38	36
MH/kWe	44	43	45

(a) NPGS = Nuclear Power Generating Station
(b) Data in January 1, 1983 Constant Dollars

TABLE 7-8 Effective Date 1/1/83

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COMPARISON OF THE PWR FOR THE 1980'S, THE PWR FOR THE 1990's AND THE HS8
FACTORY EQUIPMENT PLUS SITE MATERIAL COSTS

		January 1, 1983 Constant Dollars					
		PWR for the 1980's[a]		PWR for the 1990's[a]		HS8[b]	
		$ x 10^6	$/kWe	$ x 10^6	$/kWe	$ x 10^6	$/kWe
NSSS or FSSS:		144	126	144	126	73	92
SO_2 Removal System:[c]		-	-	-	-	66	83
T/G Unit:		108	95	108	95	60	76
Mechanical:	Coal & Ash Handling	-	-	-	-	21	26
	Electrostatic Precipitators	-	-	-	-	12	15
	Other Equipment	31	28	30	27	20	25
	Cooling Towers	13	11	13	11	7	9
	Condensers/Heat Exchangers	19	17	19	17	7	9
	Pumps	11	10	11	10	7	9
	Special Process	6	5	6	5	2	3
	Water Treatment	5	4	5	4	2	3
	Sub-Total - Mechanical	85	75	84	74	78	99
Piping:	Pipe	56	49	38	34	16	20
	Valves	17	15	17	15	4	5
	Supports/Specialties	8	7	6	5	4	5
	Sub-Total - Piping	81	71	61	54	24	30
Electrical/I&C:	Equipment	33	29	32	28	18	22
	I&C	19	17	19	17	7	9
	Wire/Cable	13	11	11	10	7	9
	Raceway	4	4	3	3	2	3
	Sub-Total - E/I&C	69	61	65	58	34	43
Structural Support:	Structural Steel	18	16	13	11	25	32
	Reinforcing Steel	20	17	13	11	3	4
	Concrete/Embedded Steel Work	19	17	14	12	11	14
	Formwork	6	5	2	2	1	1
	Sub-Total - Struc. Support	63	55	42	36	40	51
Structural (Other):		32	28	29	25	16	20
Construction Serv:[d]	Major Equipment	37	32	24	22	10	12
	Temp. Bldgs./Facilities	28	25	20	17	8	10
	Field Office Expense	16	14	11	10	2	3
	Small Tools	10	9	6	5	3	4
	Expendable Supplies/Safety	16	14	7	6	3	4
	Sub-Total - Const. Serv.	107	94	68	60	26	33
TOTAL EQUIPMENT PLUS MATERIAL		689	605	601	528	417	527
TOTAL LABOR (FROM TABLE 7-9)		1327	1165	638	560	246	311
TOTAL BASE CONSTRUCTION COSTS		2016	1770	1239	1088	663	838

(a) 1139 MWe (b) 791 MWe (d) Indirect Costs

(c) Includes lime handling, slurry preparation, SO_2 absoprtion, waste slurry thickening, waste stabilization, miscellaneous equipment; does not include commodities for structures or building and equipment foundations, piping, HVAC, I&C or electrical equipment.

TABLE 7-9

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COMPARISON OF THE PWR FOR THE 1980'S, THE PWR FOR THE 1990'S AND THE HS8
LABOR COSTS

		January 1, 1983 Constant Dollars					
		PWR for the 1980's[a]		PWR for the 1990's[a]		HS8[b]	
		$ x 10^6	$/kWe	$ x 10^6	$/kWe	$ x 10^6	$/kWe
Craft Labor:	Structural - Concrete Work	104	91	60	53	16	20
	- Other	58	51	36	31	22	28
	Sub-Total - Structural	162	142	96	84	38	48
	Mechanical - Piping	130	114	49	43	18	22
	- FGD/Coal/Ash	-	-	-	-	26	33
	- Other	52	46	40	35	41	52
	Sub-Total - Mechanical	182	160	89	78	85	107
	Electrical/I&C - Cable	18	16	8	7	4	5
	- Raceway	26	23	12	11	8	10
	- Other	26	23	21	18	8	10
	Sub-Total - Electrical/I&C	70	62	41	36	20	25
	Construction Services[c]	161	141	100	88	24	30
	Sub-Total - Craft Labor	575	505	326	286	167	210
Salaries:[c]	Engineering	125	110	68	59	11	14
	Field Job Supervision	170	149	36	32	11	14
	Other	25	22	12	11	2	3
	Sub-Total - Salaries	320	281	116	102	24	31
Expenses:[c]	Engineering[d]	185	162	100	88	16	20
	Field Job Supervision[d]	124	109	27	24	8	10
	Other[d]	25	22	13	11	2	3
	Sub-Total - Expenses	334	293	140	123	26	33
Insurance/Taxes:[c]	Sub-Total - Insurance/Taxes	98	86	56	49	29	37
TOTAL LABOR COSTS		1327	1165	638	560	246	311

(a) 1139 MWe (b) 795 MWe (c) Indirect costs
(d) Includes payroll expenses, overhead loading, fees, outside consultants, and relocation and other expenses.

Effective Date 1/1/83

TABLE 7-10

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST REDUCTIONS FOR THE PWR FOR THE 1990'S

Cost Reduction Area	Amount of Cost Reduction	
	1983 $ x 10^6[(a)]	% of Total
Indirect Costs	539	69
Commodity Installation (Labor) Costs	152	20
Commodity Installed (Labor plus Material) Costs	62	8
Other Installation (Labor) Costs	24	3
Total Cost Reduction	777	100

(a) Data in January 1, 1983 Constant Dollars

Effective Date 1/1/83

TABLE 7-11

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST REDUCTIONS FOR THE PWR FOR THE 1990'S
INDIRECT COSTS

Cost Reduction (CR) Area	Amount of Cost Reduction		
	1983 $ x 10^6[a]	% of CR	% of Total[c]
Field Supervision[b]	234	43	31
Home Office Engineering and Services[b]	142	26	18
Temporary Construction Facilities	47	9	6
Payroll Insurance and Taxes	41	8	5
Construction Schedule	18	3	2
Others[b]	57	11	7
Total CR	539	100	69

(a) Data in January 1, 1983 Constant Dollars
(b) Includes Payroll Expenses, Overhead Loading, Fees, Outside Consultants, and Relocation and Other Expenses.
(c) Refer to Table 7-10

TABLE 7-12

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST REDUCTIONS FOR THE PWR FOR THE 1990's
COMMODITY INSTALLATION (LABOR) COSTS

Cost Reduction (CR) Area	Amount of Cost Reduction		
	1983 $ x 10^6[a][b]	% of CR	% of Total[e]
Piping	76	50	10
Electrical	23	15	3
Formwork	10	6	1
Reinforcing Steel	10	6	1
Concrete	7	5	(c)
Ductwork	4	3	(c)
Structural Steel	4	3	(c)
Embedded Steel	2	1	(c)
Others[d]	16	11	2
Total CR	152	100	20

(a) Data in January 1, 1983 Constant Dollars
(b) These cost reductions are due to the decrease in the manhours per unit of commodity as applied to all commodities, and are expressed as a labor only cost decrease.
(c) Less than 1 percent
(d) Roofing, Siding, Doors, Painting, Earthwork and Concrete Finishing
(e) Refer to Table 7-10

Effective Date 1/1/83

TABLE 7-13

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST REDUCTIONS FOR THE PWR FOR THE 1990'S
COMMODITY INSTALLED (LABOR PLUS MATERIAL) COSTS

Cost Reduction (CR) Area	Amount of Cost Reduction		
	1983 $ x 10^6[(a)(b)]	% of CR	% of Total[(e)]
Piping	22	36	3
Structural & Embedded Steel	13	21	2
Reinforcing Steel	10	16	1
Wire, Cable, Duct Runs and Wire Containers	6	10	(c)
Formwork	4	6	(c)
Concrete	4	6	(c)
Others[(d)]	3	5	(c)
Total CR	62	100	8

(a) Data in January 1, 1983 Constant Dollars
(b) These cost reductions are due to the combination of the decrease in the manhours per unit of commodity and certain decreases in quantities of these commodities, and are expressed as a labor plus material cost decrease.
(c) Less than 1 Percent
(d) Roofing, Siding, Doors, Painting, Earthwork and Concrete Finishing
(e) Refer to Table 7-10

TABLE 7-14

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COST REDUCTIONS FOR THE PWR FOR THE 1990'S
OTHER INSTALLATION (LABOR) COSTS

Cost Reduction (CR) Area	Amount of Cost Reduction		
	1983 $ x 10^6[a]	% of CR	% of Total[c]
Liner Plate, Major Embedments, and Penetrations	5	21	(b)
Yardwork, including Dewatering and Waste Water Treatment	4	17	(b)
NSSS and Other Reactor Plant Equipment	4	17	(b)
Non-Commodity Building Work, e.g., HVAC, Drains and Lighting/Service Power	4	17	(b)
Turbine-Generator and Other Turbine Plant Equipment	3	12	(b)
Miscellaneous Plant Equipment	2	8	(b)
Qualification of Welders	1	4	(b)
Main Heat Rejection System and Electrical	1	4	(b)
Total CR	24	100	3

(a) Data in January 1, 1983 Constant Dollars
(b) Less than 1 Percent
(c) Refer to Table 7-10

Effective Date 1/1/83

TABLE 7-15

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COMMODITY QUANTITY, MANHOUR AND COST REDUCTIONS FOR THE 1990'S PWR

Commodity	Unit	Quantity x 1000		Reduction in Commodity (%)		
		1980's PWR	1990's PWR	Quantity[a]	Manhours[b]	Cost[c]
Piping	LB	18,070	14,530	20	62	53
Steel						
Reinforcing	TN	27	21	21	41	39
Structural	TN	11	7	35	49	40
Embedded	TN	1.9	1.3	31	37	37
Electrical						
Wire & Cable	LF	6,275	5,394	14	59	42
Duct Runs & Wire Cont.	LF	725	676	7	56	52
Formwork	SF	2,123	1,671	21	38	40
Concrete						
Structural	CY	172	142	17	57	44
Fill	CY	105	77	27	45	35
Total Commodity Reduction as a Percent of Total Direct Cost Reduction	NA	NA	NA	NA	82	83

(a) These reductions are due to decreases in the quantity of the commodity.
(b) These reductions are due to the combination of the decreases in commodities and the decreases in the manhours per unit of commodity.
(c) These decreases are due to the combination of (a) and (b).

FIGURE 7.1
ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
COMPARISON OF THE 1980'S AND 1990'S PWR, BWR AND LMFBR
BASE CONSTRUCTION COSTS

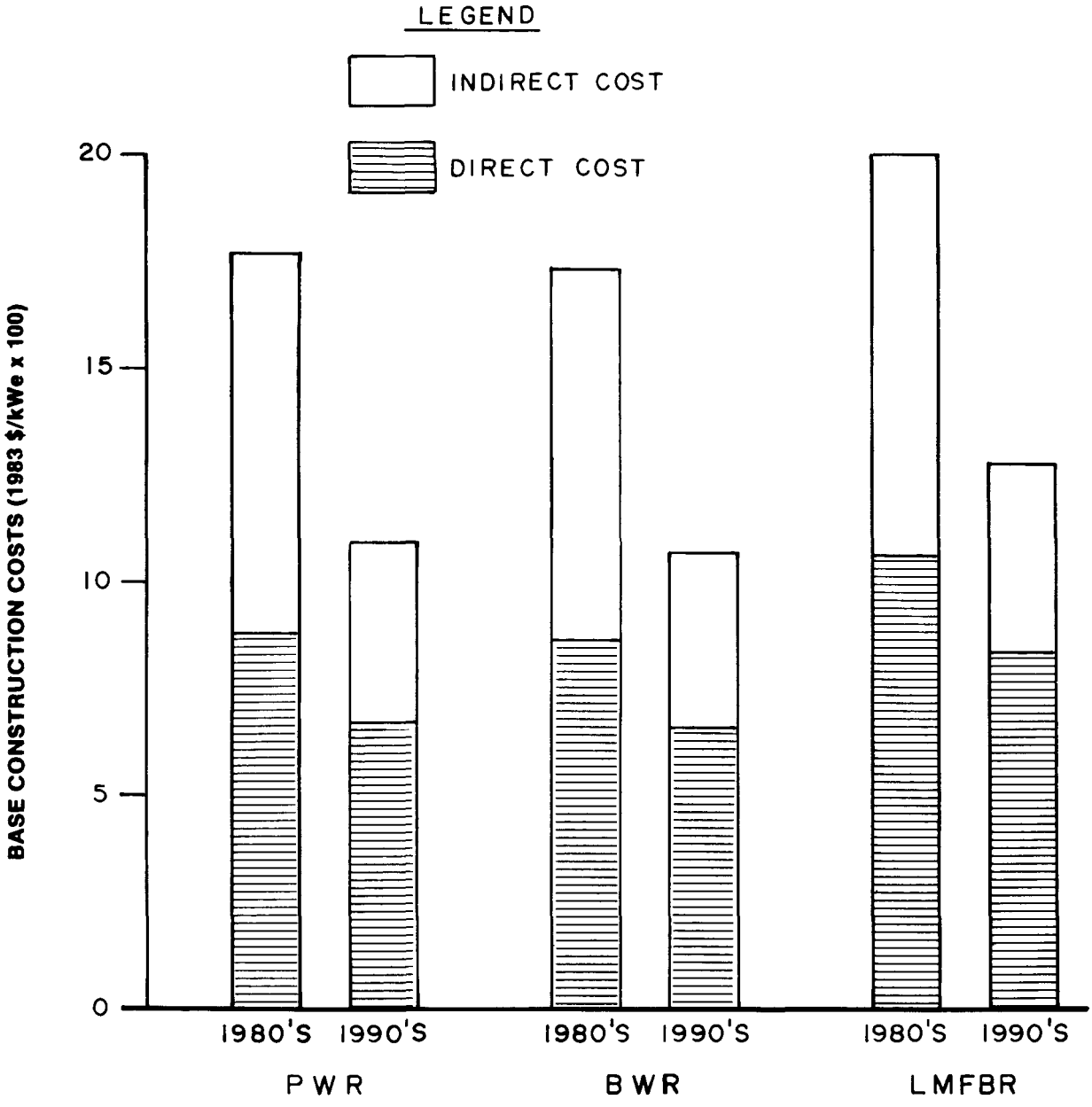


FIGURE 7.2
ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
COMPARISON OF THE 1980'S AND 1990'S PWR WITH HS 8
BASE CONSTRUCTION COSTS

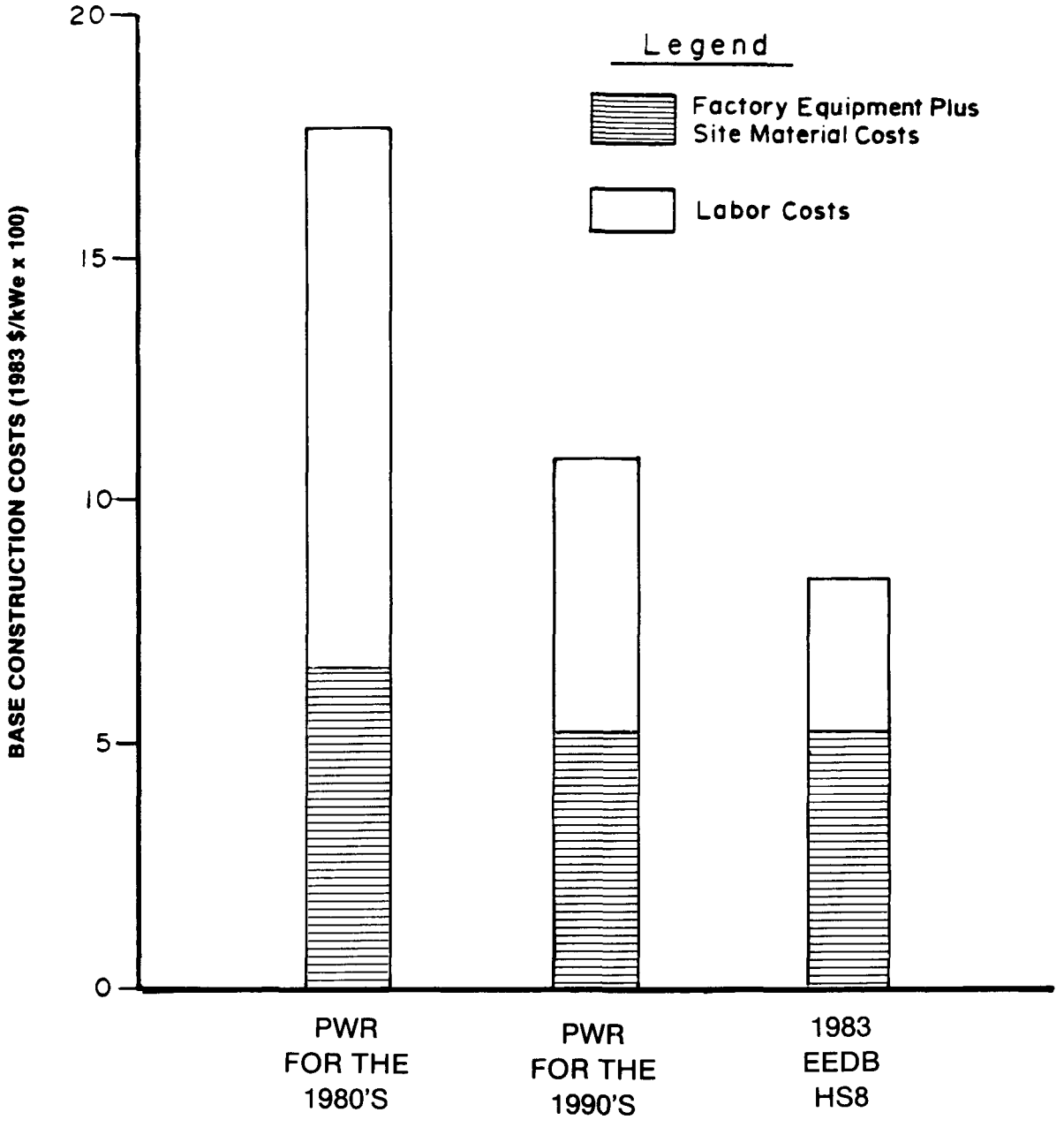


FIGURE 7.3
ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
COMPARISON OF THE 1980'S AND 1990'S PWR WITH HS 8
FACTORY EQUIPMENT COSTS PLUS SITE MATERIAL COSTS

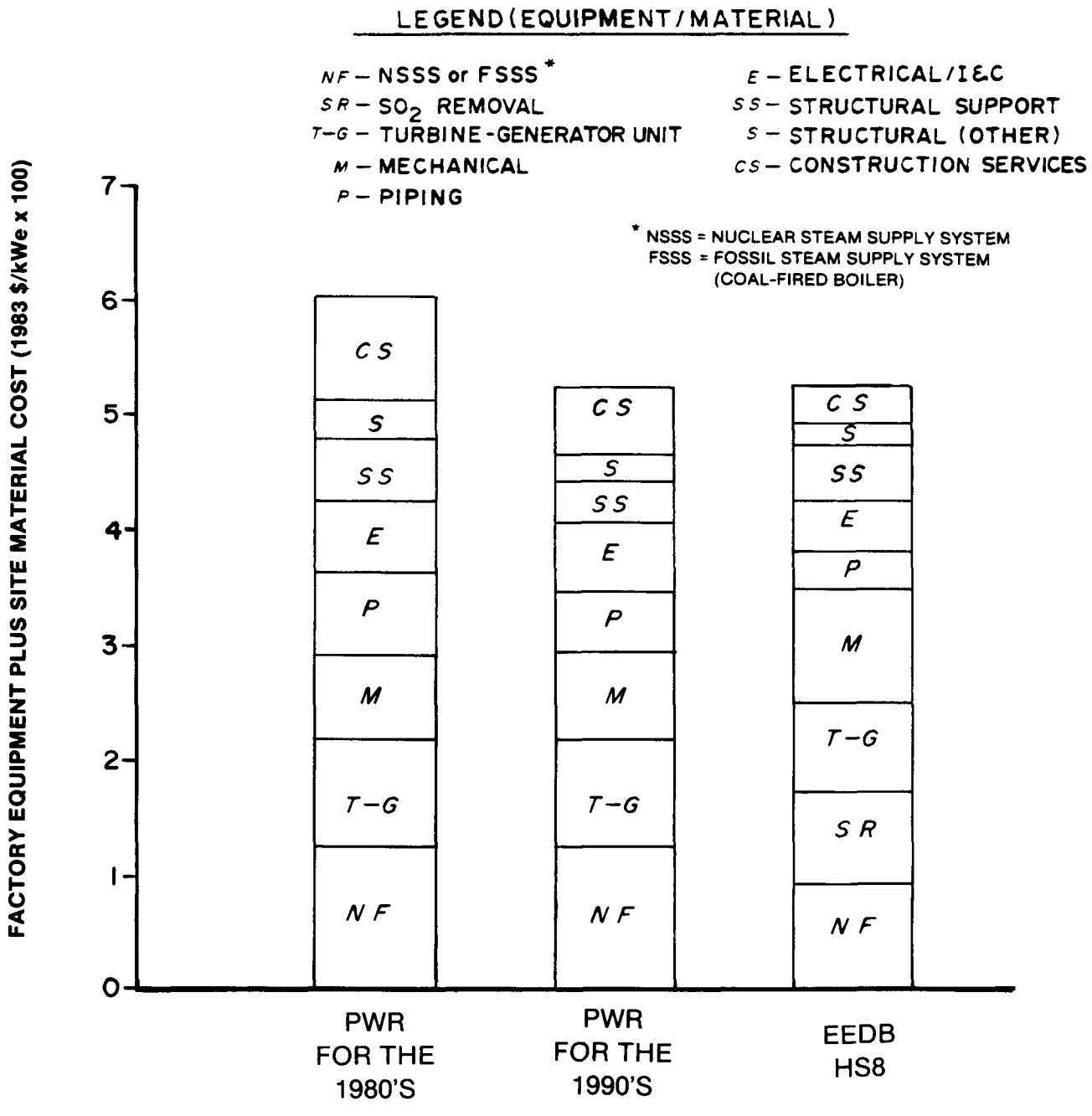
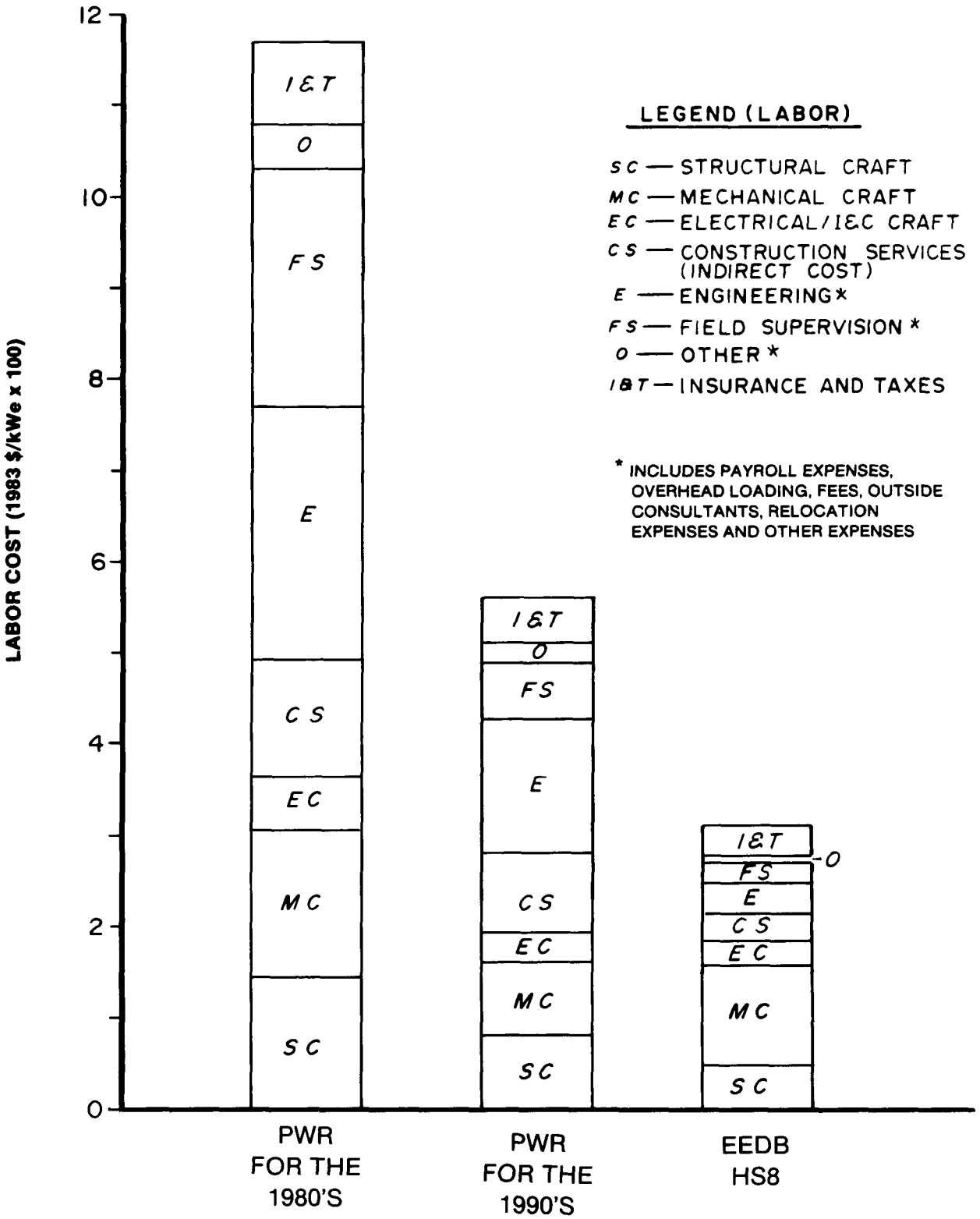


FIGURE 7.4
ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
COMPARISON OF THE 1980'S AND 1990'S PWR WITH HS 8
LABOR COSTS



SECTION 8

8.0 REFERENCES FOR THE PHASE VI UPDATE REPORT

1. "Final Report and Initial Update of the Energy Economic Data Base (EEDB) Program - Phase I", United Engineers & Constructors Inc., Philadelphia, PA 19101, UE&C/DOE-790930, U.S. Department of Energy Contract EN-78-C-02-4954, December, 1979.

2. "Phase V Update (1982) Report for the Energy Economic Data Base (EEDB) Program - EEDB-V", prepared for the U.S. Department of Energy by United Engineers & Constructors Inc., Philadelphia, PA 19101, under Contract No. CH-ENG-38-6818; July, 1983.

3. "Phase IV Final Report and Fourth Update of the Energy Economic Data Base (EEDB) Program", United Engineers & Constructors Inc., Philadelphia, PA 19101, UE&C/DOE-810930, U.S. Department of Energy Contract, (Argonne National Laboratory) 31-109-38-6411, September, 1981; and Supplement, November, 1981.

4. "Phase III Final Report and Third Update of the Energy Economic Data Base (EEDB) Program", United Engineers & Constructors Inc., Philadelphia, PA 19101, UE&C/DOE-810731, U.S. Department of Energy Contract DE-AC02-78ET33020, (formerly EN-78-C-02-4954), July, 1981.

5. "Phase II Final Report and Second Update of the Energy Economic Data Base (EEDB) Program", United Engineers & Constructors Inc., Philadelphia, PA 19101, UE&C/DOE-810430, U.S. Department of Energy Contract DE-AC02-78ET33020, (formerly EN-78-C-02-4954), April, 1981.

6. "Program Reference Book for the Energy Economic Data Base Program - EEDB", prepared for the U.S. Department of Energy by United Engineers & Constructors Inc., Philadelphia, PA 19101, under Contract No. CH-ENG-38-6818; July, 1983.

7. "Energy Economic Data Base (EEDB) Program, EEDB Program Technical Reference Book", United Engineers & Constructors Inc., Philadelphia, PA 19101, UE&C/ORNL-830930, Oak Ridge National Laboratory, Subcontract 12X-51944V, September, 1983.

8. "Commercial Electric Power Cost Studies," United Engineers & Constructors Inc., NUREG: U.S. Nuclear Regulatory Commission and/or COO: U.S. Energy Research and Development Administration.

   a. "Capital Cost: Boiling Water Reactor Plant," Volumes 1 and 2, NUREG-0242, COO-2477-6, June 1977.

   b. "Capital Cost: Pressurized Water Reactor Plant," Volumes 1 and 2, NUREG-0241, COO-2477-5, June 1977.

   c. "Capital Cost: Low and High Sulfur Coal Plants - 800 MWe (Nominal)" Volumes 1, 2 and 3, NUREG-0244, COO-2477-8, June, 1977.

APPENDIX - A

ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
PHASE VI UPDATE

U.S. NUCLEAR REGULATORY COMMISSION
REGULATORY GUIDE REVIEW

This appendix is included as a resource to support Section 4.3.2 "Review of Commodities" and other sections of this Phase VI Update Report, as noted in the text. The review documents the regulatory guide changes that have taken place between the Phase V Update (1982) and the Phase VI Update (1983).

APPENDIX A

U.S. NUCLEAR REGULATORY COMMISSION

REGULATORY GUIDE REVIEW

This list shows the revision of Regulatory Guides in effect in January 1976, January 1982, and January 1983. Each guide is noted as follows:

0	- revision 0, or original issue
1, 2 or N	- revision in effect
NI	- not issued.

A column entitled, "Relates To," shows:

D	- related to design and/or licensing
C	- related to construction
O	- related to operation
NA	- not applicable to nuclear power reactors
CI	- Regulatory Guide revision has a significant cost impact.

A summary of the Regulatory Guides (R.G.) and their revisions that are applicable to nuclear power plants and in effect on January 1, 1976, January 1, 1982 and January 1, 1983 is as follows:

R.G. Division	1976	1982	1983
1	100	138	137
2	NA	NA	NA
3	NA	3	7
4	12	14	15
5	22	28	29
6	NA	NA	NA
7	4	8	9
8	14	24	24
9	3	4	4
10	3	6	6
Total	158	225	231

REGULATORY GUIDES

Division 1 Regulatory Guides
Power Reactors

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
1.1	Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal System Pumps	0	0	0	D
1.2	Thermal Shock to Reactor Pressure Vessels	0	0	0	D
1.3	Assumptions Used for Evaluating the Potential Radiological Consequence of a Loss of Coolant Accident for Boiling Water Reactors	2	2	2	D
1.4	Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors	2	2	2	D
1.5	Assumptions Used for Evaluating the Potential Radiological Consequences of a Steam Line Break Accident for Boiling Water Reactors	0	0	0	D
1.6	Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems	0	0	0	D
1.7	Control of Combustible Gas Concentrations in Containment Following a Loss of Coolant Accident	0	2	2	D
	Supplement to Safety Guide 7, Backfitting Considerations	0	#	-	D
1.8	Personnel Selection and Training	1	1	1	0
1.9	Selection, Design, and Qualification of Diesel Generator Units Used as Standby (Onsite) Electric Power at Nuclear Power Plants	0	2	2	D
1.10	Mechanical (Cadweld) Splices in Reinforcing Bars of Category I Concrete Structures	1	(Withdrawn 7/8/81)		-
1.11	Instrument Lines Penetrating Primary Reactor Containment	0	0	0	D
	Supplement to Safety Guide 11, Backfitting Considerations	0	0	0	D

Refer to page A-2

Replaced by Regulatory Guide 1.7 - Revision 1, Issued 9/76

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
1.12	Instrumentation for Earthquakes	1	1	1	D
1.13	Spent Fuel Storage Facility Design Basis	1	1	1	D
1.14	Reactor Coolant Pump Flywheel Integrity	1	1	1	D
1.15	Testing of Reinforcing Bars for Category I Concrete Structures	1	(Withdrawn 7/8/81)		-
1.16	Reporting of Operating Information - Appendix A Technical Specifications	4	4	4	0
1.17	Protection of Nuclear Plants Against Industrial Sabotage	1	1	1	D, 0 (CI)
1.18	Structural Acceptance Test for Concrete Primary Reactor Containments	1	(Withdrawn 7/8/81)		-
1.19	Nondestructive Examination of Primary Containment Liner Welds	1	(Withdrawn 7/8/81)		-
1.20	Comprehensive Vibration Assessment Program for Reactor Internals During Preoperational and Initial Startup Testing	1	2	2	0
1.21	Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants	1	1	1	0
1.22	Periodic Testing of Protection System Actuation Functions	0	0	0	0
1.23	Onsite Meteorological Programs	0	0	0	0
1.24	Assumptions Used for Evaluating the Potential Radiological Consequences of a Pressurized Water Reactor Gas Storage Tank Failure	0	0	0	D
1.25	Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors	0	0	0	D

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
1.26	Quality Group Classifications and Standards for Water-, Steam- and Radioactive-Waste-Containing Components of Nuclear Power Plants	2	3	3	D
1.27	Ultimate Heat Sink for Nuclear Power Plants	2	2	2	D
1.28	Quality Assurance Program Requirements (Design and Construction)	0	2	2	D, C
1.29	Seismic Design Classification	1	3	3	D
1.30	Quality Assurance Requirements for the Installation, Inspection, and Testing of Instrumentation and Electric Equipment	0	0	0	C
1.31	Control of Ferrite Content in Stainless Steel Weld Metal	1	3	3	C
1.32	Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants	1	2	2	D
1.33	Quality Assurance Program Requirements (Operation)	0	2	2	O
1.34	Control of Electroslag Weld Properties	0	0	0	C
1.35	Inservice Inspection of Ungrouted Tendons in Prestressed Concrete Containment Structures	2	2	2	C
1.36	Nonmetallic Thermal Insulation for Austenitic Stainless Steel	0	0	0	D
1.37	Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water-Cooled Nuclear Power Plants	0	0	0	C
1.38	Quality Assurance Requirements for Packaging, Shipping, Receiving, Storage, and Handling of Items for Water-Cooled Nuclear Power Plants	1	2	2	C
1.39	Housekeeping Requirements for Water-Cooled Nuclear Power Plants	1	2	2	C, O

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
1.40	Qualification Tests of Continuous-Duty Motors Installed Inside the Containment of Water-Cooled Nuclear Power Plants	0	0	0	D
1.41	Preoperational Testing of Redundant Onsite Electric Power Systems to Verify Proper Load Group Assignments	0	0	0	C
1.42	Interim Licensing Policy on As-Low-As-Practicable for Gaseous Radio-Iodine Releases from Light-Water-Cooled Nuclear Power Reactors	0	(Withdrawn 3/18/76)		-
1.43	Control of Stainless Steel Weld Cladding of Low-Alloy Steel Components	0	0	0	C
1.44	Control of the Use of Sensitized Stainless Steel	0	0	0	C
1.45	Reactor Coolant Pressure Boundary Leakage Detection Systems	0	0	0	D
1.46	Protection Against Pipe Whip Inside Containment	0	0	0	D
1.47	Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems	0	0	0	D, O
1.48	Design Limits and Loading Combinations for Seismic Category I Fluid System Components	0	0	0	D
1.49	Power Levels of Nuclear Power Plants	1	1	1	D
1.50	Control of Preheat Temperature for Welding of Low-Alloy Steel	0	0	0	C
1.51	Inservice Inspection of ASME Code Class 2 and 3 Nuclear Power Plant Components	(Withdrawn 7/15/75)#		-	-
1.52	Design, Testing, and Maintenance Criteria for Post Accident Engineered-Safety-Feature Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants	NI	2	2	D, O

Regulatory Guide Revision 0, Issued 5/73

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
1.53	Application of the Single-Failure Criterion to Nuclear Power Plant Protection Systems	0	0	0	D
1.54	Quality Assurance Requirements for Protective Coatings Applied to Water-Cooled Nuclear Power Plants	0	0	0	D, C
1.55	Concrete Placement in Category I Structures	0	(Withdrawn 7/8/81)		-
1.56	Maintenance of Water Purity in Boiling Water Reactors	0	1	1	0
1.57	Design Limits and Loading Combinations for Metal Primary Reactor Containment System Components	0	0	0	D
1.58	Qualification of Nuclear Power Plant Inspection, Examination, and Testing Personnel	0	1	1	C
1.59	Design Basis Floods for Nuclear Power Plants	1	2#	2#	D
1.60	Design Response Spectra for Seismic Design of Nuclear Power Plants	1	1	1	D
1.61	Damping Values for Seismic Design of Nuclear Power Plants	0	0	0	D
1.62	Manual Initiation of Protective Actions	0	0	0	D, O
1.63	Electric Penetration Assembles in Containment Structures for Light-Water-Cooled Nuclear Power Plants	0	2	2	D
1.64	Quality Assurance Requirements for the Design of Nuclear Power Plants	1	2	2	D
1.65	Materials and Inspections for Reactor Vessel Closure Studs	0	0	0	D, C, O
1.66	Nondestructive Examination of Tubular Products	0	(Withdrawn 9/28/77)		-

Errata Issued 7/30/80

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
1.67	Installation of Overpressure Protection Devices	0	0 (Withdrawn 4/15/83)		D, C
1.68	Initial Test Programs for Water-Cooled Nuclear Power Plants	0	2	2	C, O
1.68.1	Preoperational and Initial Startup Testing of Feedwater and Condensate Systems for Boiling Water Reactor Power Plants	NI	1	1	C, O
1.68.2	Initial Startup Test Program to Demonstrate Remote Shutdown Capability for Water-Cooled Nuclear Power Plants	NI	1	1	C, O
1.68.3	Preoperational Testing of Instrument and Control Air Systems	NI	NI	0	O
1.69	Concrete Radiation Shields for Nuclear Power Plants	0	0	0	D
1.70	Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants-LWR Edition	2	3	3	D
1.71	Welder Qualification for Areas of Limited Accessibility	0	0	0	C
1.72	Spray Pond Piping Made from Fiberglass-Reinforced Thermosetting Resin	0	2	2	D
1.73	Qualification Tests of Electric Valve Operators Installed Inside the Containment of Nuclear Power Plants	0	0	0	C
1.74	Quality Assurance Terms and Definitions	0	0	0	D, C, O
1.75	Physical Independence of Electric Systems	1	2	2	D
1.76	Design Basis Tornado for Nuclear Power Plants	0	0	0	D
1.77	Assumptions Used for Evaluating a Control Rod Ejection Accident for Pressurized Water Reactors	0	0	0	D

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
1.78	Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release	0	0	0	D
1.79	Preoperational Testing of Emergency Core Cooling Systems for Pressurized Water Reactors	1	1	1	C, O
1.80	Preoperational Testing of Instrument Air Systems	0	0 (Withdrawn 4/20/82)		-
1.81	Shared Emergency and Shutdown Electric Systems for Multi-Unit Nuclear Power Plants	1	1	1	D
1.82	Sumps for Emergency Core Cooling and Containment Spray Systems	0	0	0	D
1.83	Inservice Inspection of Pressurized Water Reactor Steam Generator Tubes	1	1	1	O
1.84	Design and Fabrication Code Case Acceptability - ASME Section III, Division I	8	18	20	D, C, O
1.85	Materials Code Case Acceptability - ASME Section III, Division I	8	18	20	D, C, O
1.86	Termination of Operating Licenses for Nuclear Reactors	0	0	0	O
1.87	Guidance for Construction of Class 1 Components in Elevated-Temperature Reactors (Supplement to ASME Section III Code Cases 1592, 1593, 1594, 1595 and 1596)	1	1	1	D
1.88	Collection, Storage, and Maintenance of Nuclear Power Plant Quality Assurance Records	1	2	2	D, C, O
1.89	Qualification of Class 1E Equipment for Nuclear Power Plants	0	0	0	D, C
1.90	Inservice Inspection of Prestressed Concrete Containment Structures with Grouted Tendons	0	1	1	D, C, O

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
1.91	Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants	0	1	1	D
1.92	Combining Modal Responses and Spatial Components in Seismic Response Analysis	0	1	1	D
1.93	Availability of Electric Power Sources	0	0	0	D
1.94	Quality Assurance Requirements for Installation, Inspection, and Testing of Structural Concrete and Structural Steel During the Construction Phase of Nuclear Power Plants	0	1	1	C
1.95	Protection of Nuclear Power Plant Control Room Operators Against an Accidental Chlorine Release	0	1	1	D
1.96	Design of Main Steam Isolation Valve Leakage Control Systems for Boiling Water Reactor Nuclear Power Plants	0	1	1	D
1.97	Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident	0	2	2	D, O
1.98	Assumptions Used for Evaluating the Potential Radiological Consequences of a Radioactive Offgas System Failure in a Boiling Water Reactor	NI	0	0	D
1.99	Effects of Residual Elements on Predicted Radiation Damage to Reactor Vessel Materials	0	1	1	D
1.100	Seismic Qualification of Electric Equipment for Nuclear Power Plants	0	1	1	D, C
1.101	Emergency Planning and Preparedness for Nuclear Power Reactors	0	2	2	O
1.102	Flood Protection for Nuclear Power Plants	0	1	1	D

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
1.103	Post-Tensioned Prestressing Systems for Concrete Reactor Vessels and Containments	0	(Withdrawn 7/8/81)		-
1.104	Overhead Crane Handling Systems for Nuclear Power Plants	NI	(Withdrawn 8/16/79)#		-
1.105	Instrument Setpoints	0	1	1	D, O
1.106	Thermal Overload Protection for Electric Motors on Motor-Operated Valves	0	1	1	D
1.107	Qualifications for Cement Grouting for Prestressing Tendons in Containment Structures	0	1	1	C
1.108	Periodic Testing of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants	0	1	1	O
1.109	Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I	NI	1	1	D
1.110	Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors	NI	0	0	D
1.111	Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors	NI	1	1	D, O
1.112	Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors	NI	0	0	D, O
1.113	Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I	NI	1	1	D, O
1.114	Guidance on Being Operator at the Controls of a Nuclear Power Plant	NI	1	1	O

Regulatory Guide Revision 0, Issued 2/76

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates to
1.115	Protection Against Low-Trajectory Turbine Missiles	NI	1	1	D
1.116	Quality Assurance Requirements for Installation, Inspection, and Testing of Mechanical Equipment and Systems	NI	0	0	C
1.117	Tornado Design Classification	NI	1	1	D
1.118	Periodic Testing of Electric Power and Protective Systems	NI	2	2	O
1.119	Surveillance Program for New Fuel Assembly Designs	NI	(Withdrawn 6/23/77)#		-
1.120	Fire Protection Guidelines for Nuclear Power Plants	NI	1	1	D(CI)
1.121	Bases for Plugging Degraded PWR Steam Generator Tubes	NI	0	0	C
1.122	Development of Floor Design Response Spectra for Seismic Design of Floor-Supported Equipment or Components	NI	1	1	D
1.123	Quality Assurance Requirements for Control of Procurement of Items and Services for Nuclear Power Plants	NI	1	1	D, C
1.124	Service Limits and Loading Combinations for Class 1 Linear-Type Component Supports	NI	1	1	D
1.125	Physical Models for Design and Operation of Hydraulic Structures and Systems for Nuclear Power Plants	NI	1	1	D
1.126	An Acceptable Model and Related Statistical Methods for the Analysis of Fuel Densification	NI	1	1	O
1.127	Inspection of Water Control Structures Associated with Nuclear Power Plants	NI	1	1	C, O
1.128	Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants	NI	1	1	D, C (CI)

Regulatory Guide Revision 0, Issued 6/76

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
1.129	Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Nuclear Power Plants	NI	1	1	0
1.130	Service Limits and Loading Combinations for Class 1 Plate-and-Shell-Type Component Supports	NI	1	1	D
1.131	Qualification Tests of Electric Cables, Field Splices, and Connections for Light-Water-Cooled Nuclear Power Plants	NI	0	0	C
1.132	Site Investigations for Foundations of Nuclear Power Plants	NI	1	1	D
1.133	Loose-Part Detection Program for the Primary System of Light-Water-Cooled Reactors	NI	1	1	D, C, 0
1.134	Medical Evaluation of Nuclear Power Plant Personnel Requiring Operator Licenses	NI	1	1	0
1.135	Normal Water Level and Discharge at Nuclear Power Plants	NI	0	0	0
1.136	Materials, Construction and Testing of Concrete Containments (Articles CC-1000, -2000, and -4000 through -6000 of the "Code for Concrete Reactor Vessels and Containments")	NI	2	2	C
1.137	Fuel-Oil Systems for Standby Diesel Generators	NI	1	1	D
1.138	Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants	NI	0	0	D
1.139	Guidance for Residual Heat Removal	NI	0	0	D
1.140	Design, Testing and Maintenance Criteria for Normal Ventilation Exhaust System, Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants	NI	1	1	D

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
1.141	Containment Isolation Provisions for Fluid Systems	NI	0	0	D
1.142	Safety-Related Concrete Structures for Nuclear Power Plants (Other than Reactor Vessels and Containments)	NI	1	1	D
1.143	Design Guidance for Radioactive Waste Management Systems, Structures and Components Installed in Light-Water-Cooled Nuclear Power Plants	NI	1	1	D
1.144	Auditing of Quality Assurance Programs for Nuclear Power Plants	NI	1	1	0
1.145	Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants	NI	0	1	D
1.146	Qualification of Quality Assurance Program Audit Personnel for Nuclear Power Plants	NI	0	0	D, C, 0
1.147	Inservice Inspection Code Case Acceptability, ASME Section XI Division I.	NI	0	1	D, C, 0
1.148	Functional Specification for Active Valve Assemblies in Systems Important to Safety in Nuclear Power Plants	NI	0	0	D
1.149	Nuclear Power Plant Simulators for Use in Operator Training	NI	0	0	0
1.150	Ultrasonic Testing of Reactor Vessel Welds during Preservice and Inservice Examinations	NI	0	0	C, 0

Division 2 Regulatory Guides
Research and Test Reactors

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
2.1	Shield Test Program for Evaluation of Installed Biological Shielding in Research and Training Reactors	0	0	0	NA
2.2	Development of Technical Specifications for Experiments in Research Reactors	0	0	0	NA
2.3	Quality Verification for Plate-Type Uranium-Aluminum Fuel Elements for Use in Research Reactors	0	1	1	NA
2.4	Review of Experiments for Research Reactors	NI	0	0	NA
2.5	Quality Assurance Program Requirements for Research Reactors	NI	0	0	NA
2.6	Emergency Planning for Research Reactors	NI	0	0	NA

*Refer to page A-2

Division 3 Regulatory Guides
Fuels and Materials Facilities

Number	Title	Revision in Effect 1/76	1/82	1/83	Related to
3.1	Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material	0	1	1	NA
3.2	Efficiency Testing of Air-Cleaning Systems Containing Devices for Removal of Particles	0	0	0	NA
3.3	Quality Assurance Program Requirements for Fuel Reprocessing Plants and for Plutonium Processing and Fuel Fabrication Plants	1	1	1	NA
3.4	Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors	0	1	1	NA
3.5	Standard Format and Content of License Applications for Uranium Mills	0	1	1	NA
3.6	Content of Technical Specifications for Fuel Reprocessing Plants	0	0	0	NA
3.7	Monitoring of Combustible Gases and Vapors in Plutonium Processing and Fuel Fabrication Plants	0	0	0	NA
3.8	Preparation of Environmental Reports for Uranium Mills	0	1	2	NA
3.9	Concrete Radiation Shields	0	0	0	NA
3.10	Liquid Waste Treatment System Design Guide for Plutonium Processing and Fuel Fabrication Plants	0	0	0	NA
3.11	Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills	1	2	2	NA
3.11.1	Operational Inspection and Surveillance of Embankment Retention Systems for Uranium Mill Tailings	NI	1	1	NA
3.12	General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants	0	1	1	NA

* Refer to page A-2

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
3.13	Guide for Acceptable Waste Storage Methods at UF_6 Production Plants	0	0	0	NA
3.14	Seismic Design Classification for Plutonium Processing and Fuel Fabrication Plants	0	0	0	NA
3.15	Standard Format and Content of License Applications for Storage Only of Unirradiated Reactor Fuel and Associated Radioactive Material	0	0	0	NA
3.16	General Fire Protection Guide for Plutonium Processing and Fuel Fabrication Plants	0	0	0	NA
3.17	Earthquake Instrumentation for Fuel Reprocessing Plants	0	0	0	NA
3.18	Confinement Barriers and Systems for Fuel Reprocessing Plants	0	0	0	NA
3.19	Reporting of Operating Information for Fuel Reprocessing Plants	0	0	0	NA
3.20	Process Offgas Systems for Fuel Reprocessing Plants	0	0	0	NA
3.21	Quality Assurance Requirements for Protective Coatings Applied to Fuel Reprocessing and to Plutonium Processing and Fuel Fabrication Plants	0	0	0	NA
3.22	Periodic Testing of Fuel Reprocessing Plant Protection System Actuation Functions	0	0	0	NA
3.23	Stabilization of Uranium-Thorium Milling Waste Retention Systems	0	(Withdrawn 10/21/80)		-
3.24	Guidance on the License Application, Siting, Design, and Plant Protection for an Independent Spent Fuel Storage Installation	0	(Withdrawn 2/18/81)		-

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
3.25	Standard Format and Content of Safety Analysis Reports for Uranium Enrichment Facilities	0	0	0	NA
3.26	Standard Format and Content of Safety Analysis Reports for Fuel Reprocessing Plants	0	0	0	NA
3.27	Nondestructive Examination of Welds in the Liners of Concrete Barriers in Fuel Reprocessing Plants	0	1	1	NA
3.28	Welder Qualification for Welding in Areas of Limited Accessibility in Fuel Reprocessing Plants and in Plutonium Processing and Fuel Fabrication Plants	0	0	0	NA
3.29	Preheat and Interpass Temperature Control for the Welding of Low-Alloy Steel for Use in Fuel Reprocessing Plants and in Plutonium Processing and Fuel Fabrication Plants	0	0	0	NA
3.30	Selection, Application, and Inspection of Protective Coatings (Paints) for Fuel Reprocessing Plants	0	0	0	NA
3.31	Emergency Water Supply Systems for Fuel Reprocessing Plants	0	0	0	NA
3.32	General Design Guide for Ventilation Systems for Fuel Reprocessing Plants	0	0	0	NA
3.33	Assumptions Used for Evaluating the Potential Radiological Consequences of Accidental Nuclear Criticality in a Fuel Reprocessing Plant	NI	0	0	NA
3.34	Assumptions Used for Evaluating the Potential Radiological Consequences of Accidental Nuclear Criticality in a Uranium Fuel Fabrication Plant	NI	1	1	NA
3.35	Assumptions Used for Evaluating the Potential Radiological Consequences of Accidental Nuclear Criticality in a Plutonium Processing and Fuel Fabrication Plant	NI	1	1	NA

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
3.36	Nondestructive Examination of Tubular Products for Use in Fuel Reprocessing Plants and in Plutonium Processing and Fuel Fabrication Plants	0	(Withdrawn 1/24/79)		-
3.37	Guidance for Avoiding Intergranular Corrosion and Stress Corrosion in Austenitic Stainless Steel Components of Fuel Reprocessing Plants	0	0	0	NA
3.38	General File Protection Guide for Fuel Reprocessing Plants	NI	0	0	NA
3.39	Standard Format and Content of License Applications for Plutonium Processing and Fuel Fabrication Plants	0	0	0	NA
3.40	Design Basis Floods for Fuel Reprocessing Plants and for Plutonium Processing and Fuel Fabrication Plants	NI	1	1	NA
3.41	Validation of Calculational Methods for Nuclear Criticality Safety	NI	1	1	NA
3.42	Emergency Planning for Fuel Cycle Facilities and Plants Licensed Under 10 CFR Parts 50 and 70	NI	1	1	NA
3.43	Nuclear Criticality Safety in the Storage of Fissile Materials	NI	1	1	NA
3.44	Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation (Water Basin Type)	NI	1	1	D, C, O
3.45	Nuclear Criticality Safety for Pipe Intersections Containing Aqueous Solutions of Enriched Uranyl Nitrate	NI	0	0	NA
3.46	Standard Format and Content of License Applications, Including Environmental Reports, for In Situ Uranium Solution Mining	NI	NI	0	NA

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
3.47	Nuclear Criticality Control and Safety of Homogeneous Plutonium-Uranium Fuel Mixtures Outside Reactor	NI	0	0	NA
3.48	Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation (Dry Storage)	NI	0	0	D, C, O
3.49	Design of Independent Spent Fuel Storage Installation (Water Basin Type)	NI	0	0	D, C
3.50	Guidance on Preparing a License Application to Store Spent Fuel in an Independent Spent Fuel Storage Installation	NI	NI	0	D, C
3.51	Calculational Models for Estimating Radiation Doses to Man from Airborne Radioactive Materials Resulting from Uranium Milling Operations	NI	NI	0	NA
3.52	Standard Format and Content for the Health and Safety Sections of License Renewal Applications for Uranium Fuel Fabrication Plants	NI	NI	0	NA
3.53	Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation	NI	NI	0	D, C, O

Division 4 Regulatory Guides
Environmental and Siting Guides

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
4.1	Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants	1	1	1	0
4.2	Preparation of Environmental Reports for Nuclear Power Stations	1	2	2	D
4.3	Measurements of Radionuclides in the Environment-Analysis of I-131 in Milk	0	(Withdrawn 12/9/76)		-
4.4	Reporting Procedure for Mathematical Models Selected to Predict Heated Effluent Dispersion in Natural Water Bodies	0	0	0	0
4.5	Measurements of Radionuclides in the Environment-Sampling and Analysis of Plutonium in Soil	0	0	0	0
4.6	Measurements of Radionuclides in the Environment-Strontium-89 and Strontium-90 Analysis	0	0	0	0
4.7	General Site Suitability Criteria for Nuclear Power Stations	1	1	1	D
4.8	Environmental Technical Specifications for Nuclear Power Plants	0	0	0	0
4.9	Preparation of Environmental Reports for Commercial Uranium Enrichment Facilities	1	1	1	NA
4.10	Irreversible and Irretrievable Commitments of Material Resources	0	(Withdrawn 11/9/77)		-
4.11	Terrestrial Environmental Studies for Nuclear Power Stations	0	1	1	D
4.12	(Not Yet Published)	-	-	-	-
4.13	Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry: Environmental Applications	NI	1	1	0
4.14	Radiological Effluent and Environmental Monitoring at Uranium Mills	NI	1	1	0

efer to page A-2

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
4.15	Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment	NI	1	1	0
4.16	Measuring, Evaluating and Reporting Radioactivity in Releases of Radioactive Materials in Liquid and Airborne Effluents from Nuclear Fuel Processing and Fabrication Plants	NI	0	0	0
4.17	Standard Format and Content of Site Characterization Reports for High-Level-Waste Geologic Repositories	NI	NI	0	NA

Division 5 Regulatory Guides
Materials and Plant Protection

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
5.1	Serial Numbering of Fuel Assemblies for Light-Water-Cooled Nuclear Power Reactors	0	0	0	0
5.2	Classification of Unirradiated Plutonium and Uranium Scrap	0	(Withdrawn 9/26/79)		-
5.3	Statistical Terminology and Notation for Special Nuclear Materials Control and Accountability	0	0	0	0
5.4	Standard Analytical Methods for the Measurement of Uranium Tetrafluoride (UF_4) and Uranium Hexafluoride (UF_6)	0	0	0	NA
5.5	Standard Methods for Chemical, Mass Spectrometric, and Spectrochemical Analysis of Nuclear-Grade Uranium Dioxide Powders and Pellets	0	0	0	NA
5.6	Standard Methods for Chemical, Mass Spectrometric and Spectrochemical Analysis of Nuclear-Grade Plutonium Dioxide Powders and Pellets and Nuclear-Grade Mixed Oxides ((U, Pu) O_2)	0	0	0	NA
5.7	Entry/Exit Control for Protected Areas, Vital Areas, and Material Access	0	1	1	D, C, O(CI)
5.8	Design Considerations for Minimizing Residual Holdup of Special Nuclear Material in Drying and Fluidized Bed Operations	1	1	1	NA
5.9	Specifications for Ge(Li) Spectroscopy Systems for Material Protection Measurements - Part I: Data Acquisition Systems	1	1	1	NA
5.10	Selection and Use of Pressure-Sensitive Seals on Containers for Onsite Storage of Special Nuclear Material	0	0	0	0
5.11	Nondestructive Assay of Special Nuclear Material Contained in Scrap and Waste	0	0	0	NA

efer to page A-2

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
5.12	General Use of Locks in the Protection and Control of Facilities and Special Nuclear Materials	0	0	0	D, O
5.13	Conduct of Nuclear Material Physical Inventories	0	0	0	0
5.14	Use of Observation (Visual Surveillance) Techniques in Material Access Areas	0	1	1	0
5.15	Security Seals for the Protection and Control of Special Nuclear Material	0	0	0	0
5.16	Standard Methods for Chemical, Mass Spectrometric, Spectrochemical, Nuclear and Radiochemical Analysis of Nuclear-Grade Plutonium Nitrate Solutions and Plutonium Metal	1	1	1	NA
5.17	Truck Identification Markings	0	0	0	0
5.18	Limit of Error Concepts and Principles of Calculation in Nuclear Materials Control	0	0	0	NA
5.19	Methods for the Accountability of Plutonium Nitrate Solutions	0	0	0	NA
5.20	Training, Equipping, and Qualifying of Guards and Watchmen	0	0	0	0
5.21	Nondestructive Uranium-235 Enrichment Assay by Gamma-Ray Spectrometry	0	0	0	NA
5.22	Assessment of the Assumption of Normality (Employing Individual Observed Values)	0	0	0	NA
5.23	In-Situ Assay of Plutonium Residual Holdup	0	0	0	NA
5.24	Analysis and Use of Process Data for the Protection of Special Nuclear Material	0	0	0	NA
5.25	Design Considerations for Minimizing Residual Holdup of Special Nuclear Material in Equipment for Wet Process Operations	0	0	0	NA

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
5.26	Selection of Material Balance Areas and Item Control Areas	1	1	1	NA
5.27	Special Nuclear Material Doorway Monitors	0	0	0	D, O
5.28	Evaluation of Shipper-Receiver Differences in the Transfer of Special Nuclear Materials	0	0	0	O
5.29	Nuclear Material Control Systems for Nuclear Power Plants	1	1	1	D, O
5.30	Materials Protection Contingency Measures for Uranium and Plutonium Fuel Manufacturing Plants	0	0	0	NA
5.31	Specially Designed Vehicle with Armed Guards for Road Shipment of Special Nuclear Material	1	1	1	O
5.32	Communication with Transport Vehicles	1	1	1	O
5.33	Statistical Evaluation of Material Unaccounted For	0	0	0	O
5.34	Nondestructive Assay of Plutonium in Scrap Material by Spontaneous Fission Detection	0	0	0	NA
5.35	Calorimetric Assay of Plutonium	0	(Withdrawn 8/19/77)		-
5.36	Recommended Practice for Dealing With Outlying Observations	0	0	0	NA
5.37	In-Situ Assay of Enriched Uranium Residual Holdup	0	0	0	NA
5.38	Nondestructive Assay of High-Enrichment Uranium Fuel Plates by Gamma-Ray Spectrometry	0	0	0	NA
5.39	General Methods for the Analysis of Uranyl Nitrate Solutions for Assay, Isotopic Distribution, and Impurity Determinations	0	0	0	NA

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
5.40	Methods for the Accountability of Plutonium Dioxide Powder	0	0	0	NA
5.41	(Not Yet Published)	-	-	-	-
5.42	Design Considerations for Minimizing Residual Holdup of Special Nuclear Material in Equipment for Dry Process Operations	0	0	0	NA
5.43	Plant Security Force Duties	0	0	0	0
5.44	Perimeter Intrusion Alarm Systems	0	2	2	D, 0
5.45	Standard Format and Content for the Special Nuclear Material Control and Accounting Section of a Special Nuclear Material License Application	0	0	0	0
5.46	(Not Yet Published)	-	-	-	-
5.47	Control and Accountability of Plutonium in Waste Material	0	0	0	NA
5.48	Design Considerations - Systems for Measuring the Mass of Liquids	0	0	0	NA
5.49	Internal Transfers of Special Nuclear Material	0	0	0	0
5.50	(Not Yet Published)	-	-	-	-
5.51	Management Review of Nuclear Material Control and Accounting Systems	0	0	0	0
5.52	Standard Format and Content of a Licensee Physical Protection Plan for Strategic Special Nuclear Material at Fixed Sites (Other than Nuclear Power Plants)	NI	2	2	NA
5.53	Qualification, Calibration, and Error Estimation Methods for Nondestructive Assay	0	0	0	NA
5.54	Standard Format and Content of Safeguards Contingency Plans for Nuclear Power Plants	NI	0	0	0

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
5.55	Standard Format and Content of Safeguards Contingency Plans for Fuel Cycle Facilities	NI	0	0	NA
5.56	Standard Format and Content of Safeguards Contingency Plans for Transportation	NI	0	0	NA
5.57	Shipping and Receiving Control of Strategic Special Nuclear Material	NI	1	1	0
5.58	Considerations for Establishing Traceability of Special Nuclear Material Accounting Measurements	NI	1	1	0
5.59	Standard Format and Content for a Licensee Physical Security Plan for the Protection of Special Nuclear Material of Moderate or Low Strategic Significance	NI	0	0	D, O
5.60	Standard Format and Content of a Licensee Physical Protection Plan for Strategic Special Nuclear Material in Transit	NI	0	0	0
5.61	Intent and Scope of the Physical Protection Upgrade Rule Requirements for Fixed Sites	NI	0	0	0
5.62	Reporting of Physical Security Events	NI	0	0	0
5.63	Physical Protection for Transient Shipments	NI	NI	0	0

Division 6 Regulatory Guides
Products

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
6.1	Leak Testing Radioactive Brachytherapy Sources	1	1	1	NA
6.2	Integrity and Test Specifications for Selected Brachytherapy Sources	1	1	1	NA
6.3	Design, Construction, and Use of Radioisotopic Power Generators for Certain Land and Sea Applications	0	0	0	NA
6.4	Classification of Containment Properties of Sealed Radioactive Sources	1	2	2	NA
6.5	General Safety Standard for Installations Using Nonmedical Sealed Gamma-Ray Sources	0	0	0	NA
6.6	Acceptance Sampling Procedures for Exempted and Generally Licensed Items Containing Byproduct Material	0	0	0	NA
6.7	Preparation to an Environmental Report to Support a Rule Making Petition Seeking an Exemption for a Radionuclide-Containing Product	0	1	1	NA
6.8	Identification Plaque for Irretrievable Well-Logging Sources	NI	0	0	NA

* Refer to page A-2

Division 7 Regulatory Guides
Transportation

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
7.1	Administrative Guide for Packaging and Transporting Radioactive Material	0	0	0	0
7.2	Packaging and Transportation of Radioactively Contaminated Biological Materials	0	0	0	NA
7.3	Procedures for Picking Up and Receiving Packages of Radioactive Material	0	0	0	0
7.4	Leakage Tests on Packages for Shipment of Radioactive Materials	0	0	0	0
7.5	Administrative Guide for Obtaining Exemptions from Certain NRC Requirements over Radioactive Material Shipments	0	0	0	0
7.6	Design Criteria for the Structural Analysis of Shipping Cask Containment Vessels	NI	1	1	D
7.7	Administrative Guide for Verifying Compliance with Packaging Requirements for Shipments of Radioactive Materials	NI	0	0	0
7.8	Load Combinations for the Structural Analysis of Shipping Casks	NI	0	0	D
7.9	Standard Format and Content of Part 71 Applications for Approval of Packaging of Type B, Large Quantity, and Fissile Radioactive Material	NI	1	1	0
7.10	Establishing Quality Assurance Programs for Packaging Used in the Transport of Radioactive Material	NI	NI	0	0

* Refer to page A-2

Division 8 Regulatory Guides
Occupational Health

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
8.1	Radiation Symbol	0	0	0	0
8.2	Guide for Administrative Practices in Radiation Monitoring	0	0	0	0
8.3	Film Badge Performance Criteria	0	0	0	0
8.4	Direct-Reading and Indirect Reading Pocket Dosimeters	0	0	0	0
8.5	Criticality and Other Interior Evacuation Signals	0	1	1	0
8.6	Standard Test Procedure for Geiger-Muller Counters	0	0	0	0
8.7	Occupational Radiation Exposure Records Systems	0	0	0	0
8.8	Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations will be as Low as is Reasonably Achievable	1	3	3	D, O
8.9	Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program	0	0	0	0
8.10	Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as is Reasonably Achievable	1	1	1	0
8.11	Applications of Bioassay for Uranium	0	0	0	0
8.12	Criticality Accident Alarm Systems	0	1	1	0
8.13	Instruction Concerning Prenatal Radiation Exposure	1	1	1	0
8.14	Personnel Neutron Dosimeters	0	1	1	0
8.15	Acceptable Programs for Respiratory Protection	NI	0	0	0
8.16	(Not Yet Published)	-	-	-	-
8.17	(Not Yet Published)	-	-	-	-

* Refer to page A-2

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
8.18	Information Relevant to Ensuring that Occupational Radiation Exposures at Medical Institutions will be as Low as Reasonably Achievable	NI	0	1	NA
8.19	Occupational Radiation Dose Assessment in Light-Water Reactor Power Plants Design Stage Man-Rem Estimates	NI	1	1	D, 0
8.20	Application of Bioassay for I-125 and I-131	NI	1	1	0
8.21	Health Physics Surveys for By-Product Material at NRC-Licensed Processing and Manufacturing Plants	NI	1	1	0
8.22	Bioassay at Uranium Mills	NI	0	0	NA
8.23	Radiation Safety Surveys at Medical Institutions	NI	1	1	NA
8.24	Health Physics Surveys During Enriched Uranium-235 Processing and Fuel Fabrication	NI	1	1	NA
8.25	Calibration and Error Limits of Air Sampling Instruments for Total Volume of Air Sampled	NI	0	0	0
8.26	Applications of Bioassay for Fission and Activation Products	NI	0	0	0
8.27	Radiation Protection Training for Personnel at Light-Water-Cooled Nuclear Power Plants	NI	0	0	0
8.28	Audible-Alarm Detectors	NI	0	0	0
8.29	Instruction Concerning Risks From Occupational Radiation Exposure	NI	0	0	0

Division 9 Regulatory Guides
Antitrust Review

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
9.1	Regulatory Staff Position Statement on Antitrust Matters	0	0	0	D
9.2	Information Needed by the NRC Staff in Connection with its Antitrust Review of Construction Permit Applications for Nuclear Power Plants	0	1	1	D
9.3	Information Needed by the AEC Regulatory Staff in Connection with its Antitrust Review of Operating License Applications for Nuclear Power Plants	0	0	0	D
9.4	Suggested Format for Cash Flow Statements Submitted as Guarantees of Payment of Retrospective Payments	NI	0	0	0

* Refer to page A-2

REGULATORY GUIDES

Division 10 Regulatory Guides
General Guides

Number	Title	Revision in Effect 1/76	1/82	1/83	Relates* to
10.1	Compilation of Reporting Requirements for Persons Subject to NRC Regulations	1	4	4	0
10.2	Guidance to Academic Institutions Applying for Specific Byproduct Material Licenses of Limited Scope	0	1	1	NA
10.3	Guide for the Preparation of Applications for Special Nuclear Material Licenses of Less than Critical Mass Quantities	0	1	1	0
10.4	Guide for the Preparation of Applications for Licenses to Process Source Material	0	1	1	0
10.5	Applications for Type A Licenses of Broad Scope	NI	1	1	0
10.6	Guide for the Preparation of Applications for Use of Sealed Sources and Devices for the Performance of Industrial Radiography	NI	1	1	C
10.7	Guide for the Preparation of Applications for Licenses for Laboratory and Industrial Use of Small Quantities of Byproduct Material	NI	1	1	NA
10.8	Guide for the Preparation of Applications for Medical Programs	NI	1	1	NA
10.9	Guide for the Preparation of Applications for Licenses for the Use of Gamma Irradiators	NI	0	0	C

* Refer to page A-2

APPENDIX - B

ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
PHASE VI UPDATE

INTERIM REPORT ON STRUCTURES UPDATE

This appendix is included as a resource to support Section 4.3.2 "Review of Commodities" and other sections of this Phase VI Update Report, as noted in the text. The interim report documents the Phase VI structures update and is the basis for the structural commodity and manhour changes made to the Phase V Update (1982) data during the Phase VI Update (1983). The changes are reflected in the Phase VI Update final reported technical/cost data.

EEDB PROGRAM
PHASE VI UPDATE (1983)
INTERIM REPORT ON STRUCTURES UPDATE

I. Introduction and Methodology

As part of the EEDB Program Phase VI Update, a detailed review was performed of structural commodities and installation manhours for the 1139 MWe pressurized water reactor nuclear power generating station (PWR). The review ensured that major building sizes and quantities were representative of current practice. In the Phase V Update, the structural manhours comprised over 45 percent of the direct manhours for the EEDB PWR and installed structural commodities contributed over 25 percent of the total direct plant cost. Since field experience indicates that these quantities have been rising in recent years (manhours in particular), it was important to review the quantities of commodities and manhours for the base nuclear power plant: the EEDB PWR.

The basis for the review was United Engineers' proprietary information for the Reference PWR. The Reference PWR is a nuclear power plant under construction, whose configuration is the basis for the EEDB PWR structural conceptual design. Quantities of structural commodities and installation manhours for the EEDB PWR were compared to the actual field experience for the Reference PWR. Except where the differences were very minor, the quantities in the EEDB technical data model have been changed to those actually used. Fifteen buildings, representing the major part of the structural quantities and costs, were chosen for detailed analysis. Quantities of concrete, formwork, reinforcing steel, and structural steel were compared, and building services and total building craft manhours were evaluated. The available field data for PWR plants currently under construction confirmed that the adjustments to the EEDB PWR quantities are reasonable in meeting the review objective stated above.

The fifteen buildings chosen for review are shown in Table B-1. The buildings were divided into three types based upon similarity with the Reference PWR. Each of these types is discussed below:

a. Type I - Primary Buildings - These seven buildings were almost identical in design for the EEDB PWR and the Reference PWR. Therefore, a direct comparison of commodities for these buildings was meaningful. The seven buildings are:

   1) Reactor Containment Building;

   2) Primary Auxiliary Building;

   3) Control Room/Diesel-Generator Building;

   4) Fuel Storage Building;

   5) Emergency Feedwater Pump Building;

   6) Main Steam and Feedwater Pipe Enclosure; and

   7) Turbine Room and Heater Bay.

The craft manhours for these buildings in the Phase V Update equaled 79 percent of the total manhours for the 15 buildings in Table B-1.

b. Type II - Primary Buildings - Three buildings were similar in design for the EEDB PWR and the Reference PWR. However, since the Reference PWR buildings are for a two unit plant, the quantities were adjusted to a single unit design for comparison with the EEDB PWR. The three buildings are:

   1) Waste Process Building;

   2) Ultimate Heat Sink Structure; and

   3) Administration and Service Building.

   The craft manhours for these buildings in the Phase V Update equaled about 19 percent of the total manhours for the 15 buildings in Table B-1.

c. Type III - Relatively Minor Buildings - Five buildings in the EEDB PWR did not have similar counterparts in the Reference PWR, because of unique design considerations associated with the Reference PWR. A direct comparison of these buildings, therefore, was not possible. Since these five buildings were estimated to require approximately two percent of the total structural manhours, a detailed review was not performed. The five buildings are:

   1) Makeup Water, Intake and Discharge Structure;

   2) Fire Pump House;

   3) Circulating Water Pump House;

   4) Cooling Tower Switchgear Building; and

   5) Makeup Water Pretreatment Building.

II. Detailed Results

The results of the review and changes to the EEDB PWR technical data model for each of the buildings are discussed below. The discussion is divided among the Type I Primary Buildings, Type II Primary Buildings, and Type III Relatively Minor Buildings, as previously defined.

A. Type I Primary Buildings

These seven buildings in the EEDB PWR were so similar to the buildings in the Reference PWR that differences between the technical data model and experience was assumed to be negligible. In the following paragraphs, only major differences in quantities of commodities and manhours are highlighted.

Table B-2 summarizes the results of the review of the Type I Primary Buildings and the changes that were incorporated into the PWR for the EEDB Phase VI Update. For the commodities, only the EEDB PWR formwork was not within 10 percent of the quantity indicated by experience. Most of the manhour changes to the EEDB technical data model from Table B-2 were accomplished by direct changes or through changes made in the unit labor quantities (e.g., manhours per cubic yard (CY) of concrete) to modify the manhours to install a unit of each specific commodity.

The commodities and total craft manhours for the technical data model and the Reference PWR for the individual buildings are compared in Table B-3. The excellent commodity agreements are readily apparent (e.g., the first entry under reactor containment building of 34,600 CY of concrete for the EEDB PWR versus 34,336 CY indicated by experience).

Table B-4 summarizes the changes and their magnitudes by individual buildings. The total increase of almost one-half million manhours equaled about eight percent of the craft manhours expended in constructing these seven major structures.

1. Reactor Containment Building - The construction of this major structure required about 32 percent of the manhours (MH) needed to build the 15 EEDB PWR structures listed in Table B-1. The variations between the estimated quantities for the EEDB PWR and those used in the Reference PWR were small enough to be neglected. The net construction time increase for the EEDB PWR containment building equaled about 451,000 MH.

2. Primary Auxiliary Building - The construction of this major building required about 11 percent of the manhours needed for the 15 EEDB PWR buildings. Since the technical data model has 13 percent more concrete than experience indicated was needed, this commodity was reduced while the others remain unchanged. Also, building services were increased by about 42,000 MH. The net construction time increase for the EEDB PWR primary auxiliary building was about 142,000 MH.

3. Control Room/Diesel Generator Building - The construction of this major building required about 13 percent of the manhours needed for the 15 EEDB PWR buildings. Since the technical data model has 19 percent more concrete and 40 percent more formwork than experience indicated was needed, these commodities were reduced. Interior walls increased by 60,000 MH; this increase was primarily caused by a 15,000 square foot (SF) fire wall that was not in the Phase V techanical data model. Building services were increased by 70,000 MH. The net construction time change for the EEDB PWR control room/diesel-generator building decreased by about 62,000 MH.

4. Fuel Storage Building - The construction of this building required about four percent of the manhours needed for the 15 EEDB PWR buildings. Since the technical data model has 20 percent less structural steel than experience indicated was needed, this commodity was increased.

The base slab was decreased by 30,000 MH because the time for installing the fuel pool liner was previously too high. Building services were increased by 17,000 MH. The net construction time change for the EEDB PWR fuel storage building was a decrease of about 1,000 MH.

5. Emergency Feedwater Pump Building - The construction of this building required about three percent of the manhours needed for the 15 EEDB PWR buildings. Because all of the commodities in this building exceeded those indicated by experience to be necessary, they were reduced. Building services were increased by about 9,000 MH. The net desired construction time change for the EEDB PWR emergency feedwater pump building was a decrease of about 24,000 MH.

6. Main Steam and Feedwater Pipe Enclosure - The construction of this enclosure required approximately five percent of the manhours needed for the 15 EEDB PWR buildings. Since the technical data model had about 18 percent less concrete than indicated was needed by experience, this commodity was increased. Building services were increased by about 35,000 MH. The net construction time increase for the EEDB PWR main steam and feedwater pipe enclosure was about 165,000 MH.

7. Turbine Room and Heater Bay - The construction of this major building required almost 11 percent of the manhours needed for the 15 EEDB PWR buildings. The commodity quantities were in agreement with construction experience. However, building services were increased by about 60,000 MH. The net construction time change for the EEDB PWR turbine building was decreased by about 176,000 MH.

B. Type II Primary Buildings

These three buildings in the EEDB PWR were similar in design to the buildings in the Reference PWR; however, the actual buildings service two PWR units instead of the single PWR which was the basis for the EEDB. Decreases based on experience were made to the Reference PWR data to adjust these buildings for serving a single PWR. On an overall basis, the quantities did not agree as well between the EEDB technical data model and experience as with the Type I buildings. Changes were made in seven out of the 12 commodities listed for these buildings in Table B-3. Since most of these commodity changes were decreases, the recommended decrease in the overall construction time for these three buildings was about 190,000 manhours.

1. Waste Process Building - An increase in concrete and a decrease in formwork made the commodities more consistent with experience. Building services were increased by 24,000 MH. The net construction time change for the EEDB PWR waste process building was a decrease of about 110,000 MH.

2. Ultimate Heat Sink Structure - A reduction in structural steel and an increase in reinforcing steel were the commodity changes made for this structure. Building services were

increased by 5,000 MH. The net construction time change for the EEDB PWR ultimate heat sink decreased by about 60,000 MH.

3. Administration and Service Building - The quantities of concrete, reinforcing steel, and structural steel were reduced to reflect experience.

C. Type III Relatively Minor Buildings

The Type III EEDB PWR buildings did not have counterparts in the Reference PWR that would justify an attempt to extrapolate results. Because the construction of these buildings required approximately two percent of the manhours needed to build the 15 EEDB PWR buildings listed in Table B-1, and because the changes indicated for the primary buildings were relatively small, no changes were made in the quantities or directly controlled manhours associated with these five structures. However, the chlorination building was reevaluated and found to have the primary function of housing the switchgear for the cooling towers. As well as changing the name of the building, the design was changed with an increase from 513 to 8,374 manhours.

Fill Concrete

Fill concrete was treated as part of the construction for each building in the Reference PWR, while in the EEDB PWR it was treated as a combined item under Yardwork. The 110,000 CY of fill concrete for the EEDB PWR appears reasonable (e.g., 82,000 CY of actual fill concrete was associated with the Type I Primary Buildings above and approximately 28,000 CY remain for all other items). Based on 110,000 CY of fill concrete, the 157,000 SF of formwork is reasonable, but the 820 tons (TN) of reinforcing steel were reduced to 100 TN.

III. General Results

Table B-3 shows the structural commodity quantities and building service manhours and total building manhours for each of the fifteen buildings for both the Reference PWR and the EEDB Program Phase V Update (1982) 1139 MWe PWR. As can be seen from the table, commodity quantities generally show agreement between the Phase V Update and the Reference PWR. For example, of the 28 commodity listings for the first seven buildings, only nine differ by more than 10 percent.

The agreement between manhours was not as good. Recent United Engineers' experience indicates significant increases were needed in manhours per unit for structural steel and building service erection. The latter increases were primarily associated with ductwork and hangers for the HVAC (heating, ventilating and air conditioning systems) and lighting/service power systems.

Appropriate changes were made to the PWR for the EEDB Phase VI Update (1983) based on the above analysis. However, after the changes were made, which caused a net increase of about 300,000 manhours as shown at the bottom of Table B-3, certain unit labor quantities (manhours to install a unit of commodity) were perceived to be too high based on the field survey data. The final unit labor quantities decreased the net increase to 149,000 manhours and changed the distribution of manhours from those projected in Section II. The other EEDB nuclear power plant technical data models were modified in the Phase VI Update as required to reflect the changes to the PWR.

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

TABLE B-1

MAJOR BUILDINGS CHOSEN FOR THE PHASE VI UPDATE STRUCTURAL REVIEW

1. Reactor Containment Building
2. Primary Auxiliary Building
3. Control Room/Diesel-Generator Building
4. Waste Process Building
5. Fuel Storage Building
6. Emergency Feedwater Pump Building
7. Main Steam and Feedwater Pipe Enclosure
8. Ultimate Heat Sink Structure
9. Turbine Room and Heater Bay
10. Administration & Service Building
11. Makeup Water, Intake and Discharge Structure
12. Fire Pump House
13. Circulating Water Pump House
14. Cooling Tower Switchgear Building
15. Makeup Water Pretreatment Building

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

TABLE B-2

SUMMARY OF TYPE I PRIMARY BUILDING REVIEW AND CHANGES

Commodity	Reference PWR Data	EEDB PWR Phase V Estimates
Concrete, CY	102,120	107,695
Formwork, SF	1,185,453	1,385,000
Reinforcing Steel, TN	20,251	19,450
Structural Steel, TN	8,864	8,515

Summary of Changes		MH Change to EEDB
a)	Installation of the containment liner	increase 30,000
b)	Base slab concrete	decrease 204,000
c)	Superstructure concrete, including the containment shell, dome, and interior walls	decrease 253,000
d)	Structural steel and miscellaneous iron work	increase 251,000
e)	Painting	increase 415,000
f)	Inside walls, non-concrete	increase 85,000
g)	Building services	increase 233,000
	Total of above changes	increase 557,000
	Miscellaneous unlisted changes	decrease 62,000
	OVERALL BUILDING CHANGES	INCREASE 495,000

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

TABLE B-3

BUILDING DATA COMPARISON OF THE REFERENCE PWR WITH THE EEDB PHASE V UPDATE PWR

	Quantities of Commodities and Manhours	
	Reference PWR	EEDB PWR Phase V Update Estimates
Type I Primary Buildings		
1. Reactor Containment Building:		
Concrete, CY	34,336	34,600
Formwork, SF	219,460	230,500
Reinforcing Steel, TN	11,285	10,500
Structural Steel, TN	640	625
Building Services, MH	60,140	66,834
Total Building, MH	2,997,150	2,545,658
2. Primary Auxiliary Building:		
Concrete, CY	15,275	17,300
Formwork, SF	263,199	275,700
Reinforcing Steel, TN	2,501	2,380
Structural Steel, TN	735	700
Building Services, MH	117,710	75,259
Total Building, MH	1,018,370	875,899
3. Control Room/Diesel-Generator Building:		
Concrete, CY	16,034	19,100
Formwork, SF	273,436	381,600
Reinforcing Steel, TN	2,013	2,090
Structural Steel, TN	1,147	1,185
Building Services, MH	196,090	125,335
Total Building, MH	921,900	984,088
4. Fuel Storage Building:		
Concrete, CY	8,528	8,385
Formwork, SF	106,286	97,600
Reinforcing Steel, TN	860	840
Structural Steel, TN	252	200
Building Services, MH	34,110	16,654
Total Building, MH	327,890	329,273

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

TABLE B-3 (cont'd)

BUILDING DATA COMPARISON OF THE REFERENCE PWR WITH THE EEDB PHASE V UPDATE PWR

	Quantities of Commodities and Manhours	
	Reference PWR	EEDB PWR Phase V Update Estimates
5. Emergency Feedwater Pump Building:		
Concrete, CY	2,847	4,380
Formwork, SF	45,301	107,200
Reinforcing Steel, TN	459	530
Structural Steel, TN	25	35
Building Services, MH	12,830	3,725
Total Building, MH	178,630	203,052
6. Main Steam and Feedwater Pipe Enclosure:		
Concrete, CY	8,550	6,930
Formwork, SF	106,440	117,000
Reinforcing Steel, TN	1,795	1,800
Structural Steel, TN	65	70
Building Services, MH	38,300	2,355
Total Building, MH	559,700	394,987
7. Turbine Room and Heater Bay:		
Concrete, CY	16,550	17,000
Formwork, SF	171,331	175,400
Reinforcing Steel, TN	1,338	1,310
Structural Steel, TN	6,000	5,700
Building Services, MH	120,200	57,945
Total Building, MH	662,520	838,475
SUBTOTAL OF TYPE I BUILDING MANHOURS	6,666,160	6,171,432
Type II Primary Buildings		
8. Waste Process Buildings:		
Concrete, CY	16,500	14,870
Formwork, SF	215,000	296,215
Reinforcing Steel, TN	1,750	1,855
Structural Steel, TN	800	800
Building Services, MH	66,600	42,591
Total Building, MH	765,000	875,416

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

TABLE B-3 (cont'd)

BUILDING DATA COMPARISON OF THE REFERENCE PWR WITH THE EEDB PHASE V UPDATE PWR

	Quantities of Commodities and Manhours	
	Reference PWR	EEDB PWR Phase V Update Estimates
9. Ultimate Heat Sink:		
Concrete, CY	9,510	10,420
Formwork, SF	155,000	156,560
Reinforcing Steel, TN	1,200	1,000
Structural Steel, TN	60	325
Building Services, MH	7,500	2,345
Total Building, MH	277,700	336,465
10. Administration and Service Building:		
Concrete, CY	3,100	4,550
Formwork, SF	37,900	37,900
Reinforcing Steel, TN	230	340
Structural Steel, TN	590	900
Building Services, MH	107,800	89,060
Total Building, MH	250,000	270,836
SUBTOTAL OF TYPE II BUILDING MANHOURS	1,292,700	1,482,717
Type III Relatively Minor Buildings*	Quantities of Manhours	
11. Makeup Water, Intake and Discharge Structure, Building MH	-	33,886
12. Fire Pump House, Building MH	-	17,144
13. Circulating Water Pump House, Building MH	-	88,527
14. Cooling Tower Switchgear Building, MH	-	513
15. Makeup Water Pretreatment Building, MH	-	40,039
SUBTOTAL OF TYPE III BUILDING MANHOURS	180,109	180,109
TOTAL LISTED BUILDINGS, (ITEMS 1-15), MH	8,138,969	7,834,258

* The distribution of total manhours among the minor buildings was based on an evaluation of the relative function, size and complexity of these buildings.

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

TABLE B-4

SUMMARY OF MANHOUR CHANGES FOR THE SEVEN TYPE I BUILDINGS

Structural Item	Building							MH x 10^3 Inc. (Dec.)
	RCB	PAB	CR/DGB	FSB	EFPB	MS/FPE	TR/HB	
Installation of Containment Liner	I	-	-	-	-	-	-	30
Base Slab Concrete	N	N	D	D	N	N	D	(204)
Structural Concrete	D	N	D	D	D	I	N	(253)
Structural & Misc. Steel	I	I	I	I	N	I	D	251
Painting	I	I	I	N	N	N	I	415
Building Services	N	I	I	I	N	I	I	233
Walls (other than concrete)	N	I	I	N	N	N	N	85
Miscellaneous	N	N	N	N	N	N	N	(62)
Manhours x 10^3 Increase (Decrease)	451	142	(62)	(1)	(24)	165	(176)	495

ENERGY ECONOMIC DATA BASE
PHASE VI UDPATE

TABLE B-4 (cont'd)

SUMMARY OF MANHOUR CHANGES FOR THE SEVEN TYPE I BUILDINGS

Building Abbreviations

RCB = Reactor Containment Building

PAB = Primary Auxiliary Building

CR/DGB = Control Room and Diesel-Generator Building

FSB = Fuel Storage Building

EFPB = Emergency Feedwater Pump Building

MS/FPE = Main Steam and Feedwater Pipe Enclosure

TR/HB = Turbine Room and Heater Bay

Matrix Symbols

N = No significant change; i.e. less than 10% difference between experience and EEDB Phase V Update PWR plus less than 10,000 MH required to match experience and the EEDB Phase V Update PWR.

I = Increase in MH required for EEDB to match experience.

D = Decrease in MH required for EEDB to match experience.

APPENDIX - C

ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
PHASE VI UPDATE

EXCERPTS FROM THE EXECUTIVE SUMMARY OF THE
ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
PHASE V UPDATE (1982) REPORT

This appendix is included as a resource to support Section 3.2.2, "Nuclear Power Plant Cost Drivers" and other sections of this Phase VI Update (1983) Report, as noted in the text.

The excerpts are:

"Phase V Technical/Capital Cost Update Process	pages ES-5 and ES-6
"Summary of Cost Changes"	pages ES-10 to ES-12
"Capital Cost Drivers"	pages ES-13 to ES-15
"Conclusions and Recommendations"	pages ES-15 and ES-16

EXCERPT FROM THE EXECUTIVE SUMMARY OF THE
ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
PHASE V UPDATE (1982) REPORT

PHASE V TECHNICAL/CAPITAL COST UPDATE PROCESS

Phase V Technical/Capital Cost Update Process

A field survey was conducted during the Fifth Update, to check the degree to which the EEDB reflected current construction practice for nuclear and coal-fired power plants. Information was gathered on quantities of commodities, equipment and manhours from twenty-two light water reactor (LWR) nuclear power generating stations and three coal-fired power generating stations. This information provided a representative experience sampling of utilities, architect/engineers, constructors, steam supply system manufacturers and geographic regions of the country. Site visits were made to 12 of the 22 nuclear power plants and the 3 coal-fired power plants, from which information was gathered. During the site visits, quantities of commodities, equipment and manhours, and construction practices were discussed with both engineering and site construction personnel. Representative experience benchmarks were developed, against which the EEDB models were evaluated. The evaluation benchmarks are as follows:

Quantities of Primary Commodities	Quantities of Other Commodities/ Equipment	Quantities of Manhours
Concrete	Dewatering	Manual Field Labor
Reinforcing Steel	Concrete Fill	Engineering Hours
Structural Steel	Concrete Preparation	Quality Assurance (nuclear power plants only)
Large Bore ($\geq$ 2 1/2") Piping	Embedded Steel	Non-Manual (Supervisory) Field Labor
Small Bore (< 2 1/2") Piping	Fire Protection Sys.	
Wire/Cable	Heat Exchangers	
Raceways	Instrumentation & Cont.	
	Main Heat Reject. Sys.	

Generally, the nuclear power plants were found to be in agreement with some benchmarks, but marginal with respect to others, particularly manhours. The coal-fired power plants were found to be in good agreement with the primary commodities and manual field labor benchmarks, but marginal for other commodities/equipment and manhours.

EXCERPT FROM THE EXECUTIVE SUMMARY OF THE
ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
PHASE V UPDATE (1982) REPORT

SUMMARY OF COST CHANGES

Summary of Cost Changes

A comparison of the EEDB cost changes, that have occurred between the Phase I Update in 1978 and the Phase V Update in 1982, is given in Table C-1. All of the values in Table C-1 are given in 1982 dollars, to remove the effects of inflation from the comparison. This table shows that the EEDB nuclear power plants have experienced significant base construction and O&M cost increases between 1978 and 1982, relative to the HS8. On the other hand, the table also indicates that the nuclear power plants have experienced only small fuel cost changes over this period, relative to the HS8.

Although the O&M cost changes for the nuclear power plants are larger than the base construction cost changes, the latter are more significant, because of the relative magnitudes of the two costs. Table C-2 gives a comparison of the EEDB PWR and HS8 base construction cost changes, that have occurred between 1978 and 1982. All of the values in this table are also given in 1982 dollars, to remove the effects of inflation from the comparison. Table C-2 indicates that the PWR base construction costs have increased at a rate of 13 percent per year above inflation during this period, while the HS8 base construction costs have increased at a rate of 6 percent per year above inflation. The table also indicates that the indirect costs for both the PWR and HS8 have increased at a rate that is approximately twice that for the direct costs.

Tables C-1 and C-2 identify the nuclear and coal-fired power plant cost trends implied by the results of the Phase I through Phase V Updates of the EEDB. The cost trends are most significant when they are used to compare the relative costs of the nuclear option (as represented by the EEDB PWR) and an alternative (as represented by the EEDB HS8). Therefore, a review of this relationship, in terms of the PWR/HS8 cost ratios is informative.

The nuclear/coal-fired power plant cost trends, as identified by the changes in EEDB cost ratios between 1978 and 1982, are given in Table C-3. The most significant change that has occurred has been in the EEDB PWR/HS8 capital cost ratio. This ratio has experienced a rise of forty percentage points from 1978 to 1982. The increase reflects the continuing rise of nuclear power plant quantities of commodities, equipment and manhours, relative to those in coal-fired power plants.

In the case of the PWR/HS8 fuel cost ratio, a decline of twenty percentage points has been experienced between 1978 and 1982 for near-term power plants, while the ratio has remained relatively unchanged for far-term power plants. These trends are a direct result of the changes introduced by the 1979 and 1982 revisions to the EEDB uranium and coal price projections and reflect the near-term depressed uranium market.

The PWR/HS8 O&M cost ratio has increased by approximately 70 percentage points between 1978 and 1982. Consequently, the PWR/HS8 O&M cost ratio has been reversed from being solidly favorable to nuclear power plants to being slightly favorable to coal-fired power plants.

A comparison of 1978 and 1982 costs for each EEDB nuclear power plant was also made with those of the EEDB PWR (the base nuclear power plant) at the conclusion of the Fifth Update. The comparison indicated that little relative change had taken place between these plants and the PWR in either base con-

truction costs, fuel costs or O&M costs. Therefore, trends applicable to the PWR, relative to coal-fired power plants, are also applicable to the remaining nuclear power plants in the EEDB.

Effective Date 1/1/82

TABLE C-1

ENERGY ECONOMIC DATA BASE
PHASE V UPDATE

SELECTED COMPARISON OF PHASE I (1978) AND PHASE V (1982) UPDATE
BASE CONSTRUCTION, FUEL AND OPERATING AND MAINTENANCE COST RESULTS
(Constant January 1, 1982 Dollars)

MODEL	BWR		PWR		LMFBR(1)		HS8	
MWt	3578		3412		3800		2210	
MWe	1190		1139		1457		795	
EEDB PROGRAM UPDATE	Phase I	Phase V	Phase I	Phase V	Phase I	Phase V	Phase I	Phase V
Base Construction Costs ($x10^6)	936	1503	909	1481	1379	2274	508	637
($/kWe)	787	1263	798	1300	946	1561	639	801
Fuel Costs ($/MBtu-1982)(2)	0.97	0.82	0.97	0.79	N/A	N/A	1.96	2.60
($/MBtu-2001)(2)	1.05	1.18	1.05	1.15	0.54	0.73	3.06	3.55
O&M Costs ($x10^6/yr)	19	44	19	44	24	48	25	26
($/kWe/yr)	16	37	17	39	16	33	31	33

N/A = Not Applicable

(1) MWe was 1390 for Phase I Update in 1978. Core was changed from homogeneous to heterogeneous type for Phase V Update in 1982.

(2) Levelized over 30 years from year of startup indicated.

Effective Date 1/1/82

TABLE C-2

ENERGY ECONOMIC DATA BASE
PHASE VI UPDATE

COMPARISON OF PHASE I (1978) AND PHASE V (1982) UPDATE
PWR AND HS8 BASE CONSTRUCTION COST RESULTS
($1982 x 10^6)(1)

	EEDB Program Update		Average Compound Annual Increase (%)
	Phase I	Phase V	
PWR Direct Costs	640	903	9
PWR Indirect Costs	269	578	21
PWR Base Construction Costs	909	1481	13
HS8 Direct Costs	417	509	5
HS8 Indirect Costs	91	128	9
HS8 Base Construction Costs	508	637	6

(1) Data in Constant $1982 (Inflation-free)

Effective Date 1/1/82

TABLE C-3

ENERGY ECONOMIC DATA BASE
PHASE V UPDATE

COMPARISON OF PHASE I (1978) AND PHASE V (1982) UPDATE
PWR/HS8[1] BASE CONSTRUCTION, FUEL AND O&M COST RATIOS

	PWR/HS8 Cost Ratio			
	Base Construction Cost ($[3]/kWe)	Fuel Cost, Plant Startup		O&M Cost ($[3]/yr kWe)
		YOE[2] ($[3]/MBtu)	2001 ($[3]/MBtu)	
Phase I Update (1978)	1.2	0.5	0.3	0.5
Phase V (1982)	1.6	0.3	0.3	1.2

(1) PWR: 1139 MWe
HS8: 791 MWe
(2) YOE = Year of Estimate Update
(3) Data in Constant Dollars (Inflation-free) in the Year of the Estimate

EXCERPT FROM THE EXECUTIVE SUMMARY OF THE
ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
PHASE V UPDATE (1982) REPORT

CAPITAL COST DRIVERS

Capital Cost Drivers

As shown in Table C-2, base construction costs for the EEDB nuclear power plants have increased at a rate above inflation that is more than twice that for the comparable EEDB coal-fired power plants. These costs have been found to be driven by increases in commodities, equipment and manhours, but primarily increases in manhours. Since 1978, craft manhours for the EEDB PWR have increased at an annual rate of 16%, while manhours for the EEDB HS8 have increased at an annual rate of 4%. In the same period, engineering hours and field supervision manhours have increased at annual rates of 14% and 31% respectively for the EEDB PWR, but only 3% and 8% respectively for the EEDB HS8.

Nuclear power plant manhours, including field manual and non-manual manhours and professional service hours, have been found to be driven upwards by the implementation of inefficient institutional practices. These practices are causing increases in the quantities of commodities, equipment and manhours, and are contributing to the lengthening of schedules. (Other factors contributing to the lengthening of schedules are related to utility financial, regulatory and low power demand problems.) The impact of these practices is amplified, relative to manhours, because the increasing quantities of commodities and equipment and the lengthening schedules are also driving up manhours.

Recent studies identify the following institutional practices as being major causes of rising manhours for nuclear power plant projects, both through their implementation and through their impact on commodities, equipment and schedules:

- Retrospective (backfit) application of regulations, codes and standards, or new interpretations, thereof.
- Promulgation of voluntary standards, which incorporate a leading edge of the technology.
- Field implementation of tolerances utilized in manufacturing facilities (precise, close), that are dictated by limitations of the analytical process, to seismic Category I design features.
- Interpretations of regulatory requirements requiring time consuming negotiations to resolve differences among the interpreters (e.g., regulators, applicants, design reviewers, quality assurance auditors).
- Corrections of system/equipment/component/structure physical interferences, that lead to reanalysis, redesign and rework.
- Preoccupation with procedures, design reviews, design change control, periodic audits and the documented responses thereto.

Effective Date 1/1/82

TABLE C-2

ENERGY ECONOMIC DATA BASE
PHASE V UPDATE

COMPARISON OF PHASE I (1978) AND PHASE V (1982) UPDATE
PWR AND HS8 BASE CONSTRUCTION COST RESULTS
($1982 x 10^6)(1)

	EEDB Program Update		Average Compound Annual Increase (%)
	Phase I	Phase V	
PWR Direct Costs	640	903	9
PWR Indirect Costs	269	578	21
PWR Base Construction Costs	909	1481	13
HS8 Direct Costs	417	509	5
HS8 Indirect Costs	91	128	9
HS8 Base Construction Costs	508	637	6

(1) Data in Constant $1982 (Inflation-free)

EXCERPT FROM THE EXECUTIVE SUMMARY OF THE
ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
PHASE V UPDATE (1982) REPORT

CONCLUSIONS AND RECOMMENDATIONS

Conclusions and Recommendations

The Phase V Update benefits from an extended level-of-effort and the support of a field survey. Consequently, it is a benchmark technical/cost update effort that permits the EEDB data to be related to current construction practice and experience. As a result, this update, together with the previous four EEDB updates, documents the recent rise in nuclear power plant base construction costs and identifies current nuclear/coal-fired power plant cost trends.

Although the EEDB Program does not project future costs of power, the identified trends suggest the further erosion of the cost advantage of nuclear power plants over coal-fired plants. However, the Phase V Update identifies those areas where costs are most out of control, relative to costs in coal-fired power plants. An examination of these areas indicates that it may be possible to reverse some of the adverse cost trends, because the fundamental problem appears to be institutional rather than technical in nature. Therefore, the competitive edge of nuclear power plants may be maintained and even improved, provided that appropriate action is swiftly defined and implemented.

The recent "Report of DOE Task Force on Nuclear Licensing and Regulatory Reform," October 15, 1982, recommends reforms that could shorten the licensing and construction process, provide greater assurance for public health and safety and result in reduction of the cost of electricity produced by nuclear power plants. A summary of the major provisions of the proposed reforms is given in Table C-4. Each of the major reform provisions has the capability of reducing currently rising nuclear power plant commodities and manhours. Of particular importance in this regard are provisions which have the potential to eliminate or reduce regulatory uncertainty and backfitting, lengthening construction schedules and reintroduction of previously resolved issues.

The definition and implementation of other corrective actions by the nuclear power industry in support of these reforms is appropriate in the following areas:

- Voluntary consensus standard efforts that tend to promulgate narrow based regulations rather than reporting common practice.
- Analytical techniques requiring rigid adherence to close tolerances, that are easy to achieve in manufacturing facilities but difficult to achieve during construction.
- Rigorous procedures for correcting physical interferences in the field that place a penalty on the exercise of judgement based on experience.
- Inflexible quality assurance regimes that promote preoccupation with following procedures rather than instilling incentives among personnel to produce quality work.
- Lack of universal designs, equipment, and application and construction practices.

- Limited utilization of modular design concepts that take maximum advantage of shop fabrication of systems, subsystems, and components.

TABLE C-4

ENERGY ECONOMIC DATA BASE
PHASE V UPDATE

MAJOR PROVISIONS OF THE
"REPORT OF DOE TASK FORCE ON NUCLEAR LICENSING AND REGULATORY REFORM"
OCTOBER 5, 1982

Backfitting:	Would require NRC to provide for centralized review and approval of all staff backfitting proposals.
Hearings:	Would replace the present adjudicatory hearings with a hybrid structure that would allow legislative hearings for genuine contested issues of material fact.
One-Step Licensing:	Would provide utilities with the option of applying to NRC for a construction and operating license (COL) in one proceeding, in lieu of the current two-step process under which a construction permit (CP) and an operating license (OL) must be separately obtained in different stages of the process.
Early Site Approval:	Would authorize NRC to approve sites as suitable for prospective nuclear plants in advance of a utility's decision to apply for permission to construct.
Preapproval:	Would authorize NRC to approve generic designs for entire plants or major subsystems so that, as industry conditions permit, utilities would have the option of choosing a plant of preapproved design, in lieu of a custom designed plant.

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