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COSTEAM Expansion and Improvements

Design of a Coal-Fired Atmospheric Fluidized Bed
Submodel, an Oil-Fired Submodel and
Input/Output Improvements

MASTER

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ABSTRACT

COSTEAM is an interactive computer model designed to estimate the cost of industrial steam produced by various steam plant technologies. At the end of Phase I development, the COSTEAM model included only one submodel to calculate the capital and operating costs of a conventional coal-fired boiler plant with environmental control systems. This report describes the results of Phase II development. Two new submodels are added which calculate costs for steam produced by coal-fired atmospheric fluidized bed boilers and by oil-fired boilers. COSTEAM input/output capabilities are also improved.

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1.0 INTRODUCTION

This report describes the designs of the two submodels added to COSTEAM to allow estimates of capital costs, operating and maintenance costs, and steam costs for industrial boilers using 1) atmospheric fluidized bed and 2) oil combustion. The addition of the submodels expands the capability of COSTEAM and allows comparing the costs of producing steam using three alternative technologies: conventional coal combustion with flue gas cleanup technologies, atmospheric fluidized bed, and oil combustion. COSTEAM was developed by The MITRE Corporation for the Office of Resource Applications in the Department of Energy. It is an interactive computer model designed to estimate the costs of producing industrial steam using alternative generation technologies under different environmental and economic conditions. At the end of Phase I development, COSTEAM included a conventional coal combustion submodel.*

In addition to expanding the capabilities of COSTEAM, Phase II efforts also aim at improving the model's input/output capabilities. These improvements are described first in this report.

Revised capital cost estimates for conventional coal-fired boilers and scrubbers are included in the revised COSTEAM data base (Appendix D) and are documented in the revised version of the User's Guide.**

*See MTR79W0000701, "COSTEAM-An Industrial Steam Generation Cost Model-Phase I Development," The MITRE Corporation, April 1979 for discussion of COSTEAM conventional coal submodel and other subroutines.

**MTR80W00080, "COSTEAM, An Industrial Steam Generation Cost Model - Updated Users' Manual," The MITRE Corporation, October 1980.

2.0 COSTEAM INPUT/OUTPUT IMPROVEMENTS

Two major objectives in the Phase I development of COSTEAM are flexibility and ease of use. COSTEAM is therefore an interactive computer model. The model may be run at varying levels of detail. The user has to supply only a minimum amount of information on the steam plant requirements. Other detailed information on the plant design and operation are provided by the computer unless the user wishes to alter them to reflect site-specific operating conditions, such as the capital cost of equipment or the type of equipment combination. Improvements during Phase II aim at increasing the flexibility and ease of use of COSTEAM.

2.1 Review of COSTEAM Capabilities

Table 2-1 summarizes COSTEAM capabilities at the end of Phase I. The first column lists the steam plant operating data which the user must supply to COSTEAM. The second column shows the Phase 2 capability of COSTEAM for evaluating alternative technologies. The third column describes the flexibility available in COSTEAM for changing data values. The capability of query for any parameter value is shown in column four. Finally the last column shows the variety of reports produced by COSTEAM.

Figure 2-1 describes the basic COSTEAM methodology for calculating the cost of steam. The user defines the steam plant requirements and the selection of technology as was shown in the first two columns of Table 2-1. The steam plant, as requested by the user, is subdivided into smaller units. For each subdivision, the capital and

TABLE 2-1
COSTEAM CAPABILITIES

Steam Plant Operating Data	Alternative Steam Generation Technologies	Data Changes	Query of Parameter Values	Reports
<ul style="list-style-type: none"> • Steam demand • Steam pressure • Superheat requirements • Condensate return data • Capacity factor • Start up year • Fuel type and assay • Environmental standards 	<ul style="list-style-type: none"> • Conventional coal systems <ul style="list-style-type: none"> - Stoker systems - Pulverizer systems • Atmospheric fluidized bed coal systems* <ul style="list-style-type: none"> - Vendor capital costs - Theory capital costs • Conventional oil systems* 	<ul style="list-style-type: none"> • Fuel type and assay • Environmental standards • Gas cleanup options • Waste disposal options • Technology performance parameters • Costs 	<ul style="list-style-type: none"> • The user may ask for the value of any parameter and cost used by the model before requesting reports • The user may ask for the value of any parameter before making a data change* 	<ul style="list-style-type: none"> • Summary • Capital cost summary • Detailed capital costs • Detailed material and labor costs • Plant operating characteristics • Detailed operating costs • Financial parameters • Capital costs in Energy Regulatory Administration format* • Warning messages at the terminal with the option of changing data before continuing the run*

* Developed during this Phase 2 of the COSTEAM project. The two AFB alternatives use different capital cost data reflecting current market prices and theoretical prices of a mature technology, respectively.

FIGURE 2-1
COSTEAM METHODOLOGY OVERVIEW

operating and maintenance (O & M) costs are calculated. Each cost is adjusted from the cost of that item in a reference steam plant. Adjustments are made for size, plant location, and start up time. Following the costing of each subdivision, capital and O & M costs are calculated for the plant, and a cost of steam figure is provided based on estimated plant life cycle costs.

The conventional coal submodel estimates the costs of steam from conventional stoker or pulverized coal boilers supplemented with particulate and sulfur dioxide removal equipment. The size range which may be evaluated is 50,000 to 500,000 lbs/hr of steam. There are 59 major equipment items in the subdivision of the conventional coal-fired steam plants. The atmospheric fluidized bed (AFB) submodel calculates costs for boilers in the 100,000 to 500,000 lbs/hr size range. There are 57 major equipment items in the subdivision of the AFB steam plant. The oil submodel estimates the costs of steam from packaged and field erected oil-fired boilers in the 50,000 to 500,000 lbs/hr size ranges. There are 32 major equipment items in the subdivision of the oil-fired plants.

For each major equipment item, as many as eleven capital costs may be calculated covering:

- equipment costs (1)
- material costs (6)
- labor costs (3)
- rented construction equipment cost (1).

O & M costs for the boiler plants include:

- fuel
- electricity
- water
- waste disposal
- scrubber chemicals (conventional coal-fired and oil-fired systems)
- limestone (AFB system)
- water treatment chemicals
- maintenance materials
- O & M labor

Lifetime cost of the steam plant and present value costs per pound of steam produced are calculated based on total capital costs, operating costs, plant start-up date, interest rate and inflation rates.

2.2 COSTEAM Phase II Improvements

Improvements to COSTEAM input/output capabilities are discussed in the following subsections.

2.2.1 Input/Output Enhancements

The following enhancements have been made to the input/output capabilities of COSTEAM.

1. The user-model dialog has been modified to give an improved method of querying and changing parameter values. The current value of a parameter is printed and the user then can change that value or leave it unchanged.

2. Error message processing has been added. This allows a technology submodel to check input parameters. If input parameters are inconsistent or are outside maximum or minimum values, error messages are printed, and the user may a) continue the run with the present values, b) change parameter values, or c) terminate the model run. A sample terminal session illustrating improvements 1 and 2 is shown in Figure 2-2. The Summary Report is printed automatically at the terminal. An example of this sample report is shown in Figure 2-3.
3. The calculated total capital cost for an equipment item can be overridden by the user. When the override value is zero, all capital costs for that item are set to zero. This provides the user with an easy way of accounting for existing equipment in his steam plant.
4. The subroutine which calculates the format for printing data values has been modified to improve decimal point placement and the number of digits printed.
5. The conventional coal submodel and data files have been restructured to allow up to 39 equipment items per component (24 was the maximum in the Phase 1 version). This allows a more detailed break-out of equipment items in future versions of COSTEAM. In addition, the data files for the conventional coal system have been restructured, and items labeled "off-site" in Phase I have been included in other components. A

INDUSTRIAL COST OF STEAM MODEL

PHASE 2 VERSION

ENTER BASIC OPERATIONAL PARAMETERS

ENTER STEAM DEMAND (LB/HR)

?

200000

ENTER STEAM PRESSURE (PSIG)

?

700

IS STEAM TO BE SUPERHEATED ? (YES OR NO)

YES

ENTER STEAM TEMPERATURE (DEGREES F.)

?

750

ENTER CONDENSATE RETURN (FRACTION)

?

2.0

INVALID - REENTER DATA

ENTER CONDENSATE RETURN (FRACTION)

?

0.2

ENTER CONDENSATE RETURN TEMP. (DEGREES F.)

?

230

ENTER PLANT CAPACITY FACTOR

?

.7

ENTER REGION NAME

CHICAGO

ENTER START UP YEAR

?

1984

ENTER RUN TITLE

SAMPLE AFB RUN

ENTER SYSTEM NAME

AFBCOAL

ENTER VARIANT NAME FOR SYSTEM AFBCOAL

VENDOR

ENTER NAME OF FUEL

COAL15

DO YOU WISH TO SPECIFY PARAMETERS FOR COAL15 ? (YES OR NO)

YES

ENTER PARAMETER NAME

PRICE

ENTER VALUE

?

30.00

ENTER PARAMETER NAME OR END

END

ENTER NAME OF ENVIRONMENTAL STANDARD

ENVHIGH

DO YOU WISH TO SPECIFY PARAMETERS FOR ENVHIGH ? (YES OR NO)

YES

ENTER PARAMETER NAME

SO2MAX

ENTER VALUE

?

0.8

ENTER PARAMETER NAME OR END

END

DO YOU WANT TO PRINT SPECIFIC PARAMETERS ? (YES OR NO)

YES

FOR EACH PARAMETER VALUE TO BE EXAMINED ENTER
TWO NAMES AS DESCRIBED BELOW.

THE FIRST NAME IDENTIFIES THE PARAMETER GROUP AND
MUST BE SELECTED FROM THE FOLLOWING LIST :

AFBCOAL	FUEL	ENVIRON	GLOBAL	MODEL
BOTLER	MECHANIC	INSTRUM	FUELHAND	GASCLEAN
DRYASH	WETASH	SPENTRED	AFBMATS	

THE SECOND NAME IS THE PARAMETER NAME AND
MUST BE SELECTED FROM LISTS GIVEN IN THE USER GUIDE.

ENTER 'END' TO TERMINATE.

ENTER NAMES IN EXACT POSITIONS INDICATED BELOW.

PARAM. PARAM.

GROUP NAME

.....

FIGURE 2-2

SAMPLE COSTEAM OUTPUT SESSION

FUELHAND COSEQMT

0.0

ENTER NEW VALUE OR CARRIAGE RETURN

?

85000

END

PROCESSING SYSTEM AFBCOAL

WARNING MESSAGES FOR SYSTEM AFBCOAL

ERROR 10

THE EQUIPMENT ITEMS IN THIS "VENDOR" VARIANT ARE APPROPRIATE FOR A 220,000 LB/HR BABCOCK AND WILCOX DESIGN. COSTS WERE DEVELOPED BY AFS, INC. AND REFLECT THE STATE OF THE AFB INDUSTRY IN EARLY 1980. IN ORDER TO APPROXIMATE OTHER AFB DESIGNS, YOU MAY WISH TO DELETE ITEM XX. TO DO THIS, SET "COMPONENT CXXTOTAL" TO 0. YOU CAN ALSO INSERT A KNOWN CAPITAL COST YYYYYY FOR EQUIPMENT ITEM XX BY CHANGING THE PARAMETER VALUE FOR "COMPONENT CXXYYYYY". THE COST YOU INSERT WILL OVERRIDE THE CALCULATED VALUE.

IF YOU WISH TO CONTINUE PROCESSING ENTER 'CONTINUE'

IF YOU WISH TO CHANGE PARAMETER VALUES ENTER 'CHANGE'

IF YOU WISH TO STOP PROCESSING ENTER 'STOP'

CONTINUE

PROCESSING COMPLETED

(Summary Report Printed Here)

(See Figure 2.3)

DO YOU WANT TO PRINT SPECIFIC PARAMETERS ? (YES OR NO)

YES

FOR EACH PARAMETER VALUE TO BE EXAMINED ENTER
TWO NAMES AS DESCRIBED BELOW.

THE FIRST NAME IDENTIFIES THE PARAMETER GROUP AND
MUST BE SELECTED FROM THE FOLLOWING LIST :

AFBCOAL	FUEL	ENVIRON	GLOBAL	MODEL
BOILER	MECHANIC	INSTRUM	FUELHAND	GASCLEAN
DRYASH	WETASH	SPENTRED	AFBMATS	

FIGURE 2-2
SAMPLE COSTEAM OUTPUT SESSION
(CONTINUED)

THE SECOND NAME IS THE PARAMETER NAME AND
MUST BE SELECTED FROM LISTS GIVEN IN THE USER GUIDE.

ENTER 'END' TO TERMINATE.

ENTER NAMES IN EXACT POSITIONS INDICATED BELOW.

PARAM. PARAM.
GROUP NAME

.....

BOILER COITOTAL

7120712.0

END

DO YOU WANT A REPORT TO BE WRITTEN ? (YES OR NO)

YES

STANDARD REPORT NAMES ARE :

SUMMARY SUMCAP CAPITAL DESIGN OPERATE

FINANCE MATERIAL FRA

ENTER REPORT NAME OR END
END

SPECIAL REPORT NAMES ARE :

DO YOU WISH TO PROCESS ANOTHER SYSTEM ? (YES OR NO)
NO

'ALLS' FOR ALL STANDARD REPORTS

'ALIP' FOR A REPORT OF ALL PARAMETERS
(NOT RECOMMENDED FOR TERMINAL PRINT)

'ALLU' FOR A REPORT OF ALL SYSTEM AND COMPONENT
PARAMETERS SPECIFIED BY USER

'ALL' FOR ALL REPORTS
(NOT RECOMMENDED FOR TERMINAL PRINT)

ENTER 'END' TO TERMINATE REPORTING

ENTER REPORT NAME OR END

CAPITAL

IS REPORT TO BE WRITTEN AT TERMINAL OR PRINTER ?

ENTER T FOR TERMINAL ; P FOR PRINTER ; TP FOR BOTH

P

IS REPORT TO CONTAIN PARAMETER VALUES, NAMES, OR BOTH?

ENTER VALUES , NAMES , OR BOTH.

VALUES

FIGURE 2-2
SAMPLE COSTEAM OUTPUT SESSION
(CONCLUDED)

SAMPLE AFB RUN

SUMMARY REPORT

PHASE 2 RESULTS IN 1980 DOLLARS

PRELIMINARY AFB COST DATA

SYSTEM : AFB COAL	STEAM DEMAND : 200000. (LB/HR)
VARIANT : VENDOR	STEAM PRESSURE : 700. (PSIG)
REGION : CHICAGO	STEAM TEMPERATURE : 750. (DEGREE F.) SUPERHEAT
FUEL : COAL 15	CONDENSATE RETURN : 0.200 (FRACTION)
START UP YEAR : 1984	CONDENSATE TEMP : 230. (DEGREE F.)
ENVIRONMENTAL : ENVHIGH	CAPACITY FACTOR : 0.7000 (FRACTION)
FIRING RATE : 307.3	MILLION BTUS PER HOUR

SECTION I CAPITAL COSTS (1980 DOLLARS)

	CAPITAL COST
--	-----------------

MAJOR BOILER EQUIPMENT	8127490.
---------------------------	----------

MAJOR MECHANICAL EQUIPMENT	1751570.
-------------------------------	----------

BOILER INSTRUMENTATION	485175.
---------------------------	---------

COAL HANDLING EQUIPMENT	785248.
----------------------------	---------

FLUE GAS CLEANUP AND HANDLING	1163388.
----------------------------------	----------

DRY ASH HANDLING EQUIPMENT	995212.
-------------------------------	---------

SPENT BED MATS. HANDLING EQUIPMENT	344773.
---------------------------------------	---------

COAL & LIMESTONE FEED EQUIPMENT	1212097.
------------------------------------	----------

COMPONENT SUBTOTAL	14864949.
-----------------------	-----------

ENGINEERING COST	1486495.
---------------------	----------

CONSTRUCTION MANAGEMENT	1486495.
----------------------------	----------

CONTINGENCY COST	1486495.
---------------------	----------

INTEREST DURING CONSTRUCTION	2075271.
---------------------------------	----------

COAL STOCKPILE	440097.
-------------------	---------

WORKING CAPITAL	1009443.
--------------------	----------

TOTAL	
-------	--

FIGURE 2-3
SAMPLE SUMMARY REPORT

CAPITAL COSTS 22849216.

FIRST YEAR AFTER
TAX TOTAL COST 14193408.

SECTION 2 OPERATING COSTS (1980 DOLLARS)

OPERATING
COST

FUEL
COST 2141806.

OPERATING AND
MAINTENANCE LABOR 378851.

CONSUMABLES - H2O,
ELEC., CHEMICALS 583621.

MAINTENANCE
MATERIALS 544233.

WASTE
DISPOSAL 170864.

INSURANCE
COST 218398.

TOTAL 4037770.

SECTION 3 FINANCIAL CALCULATIONS (START-UP YR \$'S)

100 PERCENT
EQUITY FINANCING

TOT. CAPITAL
COST AT START 33453424.

FIRST YEAR BEFORE
TAX TOTAL COST 10810209.

ANNUALIZED
AFTER TAX COST 21695360.

CAPITAL COST PER
LB/HR PROCESS STEAM 167.

FIRST YR BEFORE TAX
COST/1000 LB STEAM 8.81

FIRST YR AFTER TAX
COST/1000 LB STEAM 11.57

ANNUALIZE AFTER TAX
COST/1000 LB STEAM 17.69

SECTION 4 ENVIRONMENTAL RESULTS - EOMT. MEETS REGS.

ENVIRONMENTAL
REGULATIONS

SYSTEM
PERFORMANCE

PERCENT SO2
REMOVED 90.00 90.00

POUNDS SO2/MMBTU
MAX. EMISSIONS 0.8000 0.3023

NOX
POUNDS/MMBTU 0.5000 0.5000

PARTICULATES
POUNDS/MMBTU 0.0300 0.0300

FIGURE 2-3
SAMPLE SUMMARY REPORT
(CONCLUDED)

new component, "Mechanical Equipment," has been added. This will make the reports for all COSTEAM steam technologies easier to compare with each other and with the results of other models. Figure 2-4 presents the new equipment groupings for COSTEAM steam technologies. Appendix A contains additional information on the plant design for each technology.

2.2.2 ERA Report

In order to facilitate the comparison of COSTEAM output to other models during the validation of COSTEAM, the model has been modified to assign capital costs for an industrial boiler plant to the cost categories specified by the Energy Regulatory Administration (ERA).*

The user can request capital cost output in the ERA format during a terminal session of COSTEAM. This is done by entering "ERA" in response to the command "ENTER REPORT NAME OR END". A response of "ALLS" or "ALL" to the above command will produce an ERA report in addition to other reports.

The boiler equipment items are assigned to ERA cost categories by the ERA report specifications on the report data file. Alternative assignments can be made by changing the report data file.

Figure 2-6 shows the mapping of COSTEAM conventional coal plant equipment items into ERA capital cost categories.

*Instructions for Schedule B, General and Special Cost Test for New Installations ERA-318. See Figure 2-5.

I. MAJOR BOILER EQUIPMENT	BOILER*
1. Tubes, drums, headers, casing access doors, windbox ash hopper, ash reinjection	SPAO
2. Burners, atomizers	P
3. Oil ignition system	PA
4. Pulverizers, primary air fans/driven air seal system	P
5. Coal feeders, scales	P
6. Booster fan	A
7. Superheater ^H	SPAO
8. Sootblowers	SP
9. F D fan/drive	SPA
10. Air heater	SPA
11. Economizer	A
12. Spreader stoker	S
13. Direct-fired air heater	A
14. Coal scales	S

II. MECHANICAL EQUIPMENT	MELHANI*
1. Desuperheater/reducing station ^H	SPAO
2. Feedwater softeners, dealkalizers, blowdown system, deaerators & accessories	SPAO
3. Boiler feed pumps/drives	SPAO
4. Feedwater heater	SPAO
5. Valves and piping	SPAO
6. Steam coil air preheater	SPAO
7. Utilities	SPAO
8. Building and supports, stairs, floors, siding, roofing, platforms	SPAO

III. BOILER INSTRUMENTS	INSTRUM*
1. Underfeed air	S
2. Feedwater control	SPAO
3. Overfeed air	S
4. Compressed air system	SPAO
5. Control room	SPA
6. Fuel control	SPA
7. Combustion control	PA
8. Burner management	PA
9. Control panel	O
10. Instrument installation	SPAO

IV. FUEL HANDLING AND STORAGE	FUELHAND*
1. Unloading hoppers, bins, bunkers, conveyors, crushers, bucket elevator	SPA
2. Coal pile	SPA
3. Rail spur	SPA
4. Coal yard and drain system	SPA
5. Car thawer	SPA
6. Fuel oil unloading station	O
7. Fuel oil tank and spill containment	O
8. Fuel oil heater	O
9. Pumping station	O

* Computer code name

**FIGURE 2-4
STEAM PLANT COMPONENTS AND EQUIPMENT ITEMS**

V. FLUE GAS CLEANUP AND HANDLING	GASCLEAN*
1. Cyclone dust collector	SPAO
2. Baghouse ^E	SPAO
3. Electrostatic precipitator ^E	SPAO
4. Wet flue gas desulfurization scrubber recycle pump/drive scrubber make-up pump/drive caustic injection system slurry collection tank ^B caustic recycle tank	SPO
5. Dry flue gas desulfurization lime slaking and dust particulate collection and storage ^B	SPO
6. Limestone crusher	SPAO
7. Lime/limestone unloaders, conveyors, silo, bins, bunkers	SPAO
8. Lime/limestone mixing tank	SPO
9. I.D. fan/drive/coupling	SPAO
10. Stack	SPAO

* Computer code name

VI. DRY ASH HANDLING ^C	DRYASH*
1. Ash silo and accessories	SPA
2. Ejector	SPA
3. Separator	SPA
4. Air washer	SPA
5. Valves/pipes	SPA
6. Ash transport and disposal equipment	SPAO
7. Dry ash handling equipment installation	SPA

VII. WET ASH HANDLING ^C	WETASH*
1. Bottom ash conveying	SP
2. Fly ash conveying	SP
3. Water pumps	SP
4. Sluice overflow pump	SP
5. Acid feed pump	SP
6. Wet ash handling equipment installation	SP
7. Sludge dewatering ^D	SPO
8. Sludge transport ^D	SPO
9. Settling pond ^D	SPO

**FIGURE 2-4
STEAM PLANT COMPONENTS AND EQUIPMENT ITEMS
(CONTINUED)**

VIII. SPENT BED MATERIALS HANDLING	SPENIBED
1. Metering screw coolers	A
2. Spent bed makeup bins	A
3. Reinjection feeders	A
4. Makeup feeders	A
5. Bypass feeders	A

IX. COAL & LIMESTONE HANDLING	AFBMATS
1. Coal feeders	A
2. Coal screw conveyor	A
3. Limestone feeder	A
4. Mixing conveyor	A
5. Elevator	A
6. Feeder bunker	A
7. Layer loader	A
8. Down spouts	A
9. Injection feeders	A
10. Injection piping and valves	A

* Computer code name
A - AFB coal boiler
B - Selects wet or dry scrubber, or neither system, but not both using parameter GASCLEAN FSCRUB
C - Selects wet or dry ash handling, but not both using system parameter FWETA (CONVCOAL and CONVOIL)
D - Selects either settling pond or sludge dewatering and transport using parameter WETASH FDEWA
E - Selects either baghouse, precipitator, or neither system, but not both using parameter GASCLEAN FESP
H - For superheated steam only
P - Pulverized coal boiler
S - Stoker coal boiler
O - Oil fired boiler

FIGURE 2-4
STEAM PLANT COMPONENTS AND EQUIPMENT ITEMS
(CONCLUDED)

Generation Equipment

- 1a. Boilers (with fans & ducts)
- 1b. Combustion turbines/generators
- 1c. Internal combustion engines/generators
- 1d. Steam turbines/generators
- 1e. Auxiliary equipment
- 1f. Gaseous/liquid fuel handling and storage systems
- 1g. Coal/solid fuel handling systems
- 1h. Other
- 1i. Indirect costs

Fuel Inventory

- 2a. Gaseous/liquid
- 2b. Coal/solid fuel

Air Pollution Control Equipment

- 3a. Particulate control
- 3b. Indirect costs for particulate control
- 3c. SO₂ scrubber components
- 3d. Indirect costs for SO₂ scrubber components

Water Pollution Control Equipment

- 4a. Coal storage area runoff
- 4b. Pond
- 4c. Treatment system
- 4d. Other
- 5. Contingencies
- 6. Working capital
- 7. Land

FIGURE 2-5
ERA CAPITAL COST FORMAT

1. GENERATING EQUIPMENT

1a. Boilers (with fans and ducts)

- I. Major Boiler Equipment
 - 1. Tubes, drums, headers, casing access doors, windbox ash hopper, ash reinjection SPAO
 - 2. Burners, atomizers P
 - 3. Oil ignition system PA
 - 6. Booster fan A
 - 7. Superheater SPAO
 - 8. Sootblowers SP
 - 9. F.D. fan/drive SPA
 - 10. Air heater SPA
 - 11. Economizer A
 - 12. Spreader stoker S
 - 13. Direct-fired air heater A
- II. Mechanical Equipment
 - 1. Desuperheater, reducing station^H SPAO
 - 4. Feedwater heater SPAO
 - 6. Steam coil air preheater SPAO
- III. Boiler Instruments
 - 1. Underfeed air S
 - 3. Overfeed air S
 - 6. Fuel control SPA
 - 7. Combustion control PA
 - 8. Burner management PA
 - 10. Instrument installation SPAO
- V. Flue Gas Cleanup and Handling
 - 9. Induced draft fan/drive/coupling SPAO

1e. Auxiliary Equipment

- II. Mechanical Equipment
 - 2. Feedwater softeners, dealkalizers, blowdown system, dearators and accessories SPAO
 - 3. Boiler feed pumps/drives SPAO

**FIGURE 2-6
ALLOCATION OF COSTEAM EQUIPMENT ITEMS
TO ERA CAPITAL COST CATEGORIES**

1. GENERATING EQUIPMENT (Cont'd.)

1e. Auxiliary Equipment (Cont'd.)

III. Boiler Instruments

2. Feedwater control	SPAO
4. Compressed air system	SPAO
5. Control room	SPA
9. Control panel	0

V. Flue Gas Cleanup and Handling

10. Stack	SPAO
-----------	------

VI. Dry Ash Handling^C

1. Ash silo and accessories	SPA
2. Ejector	SPA
3. Separator	SPA
4. Air washer	SPA
5. Valves/pipes	SPA
6. Ash transport and disposal equipment	SPAO
7. Dry ash handling equipment installation	SPA

VII. Wet Ash Handling^C

1. Bottom ash conveying	SP
2. Fly ash conveying	SP
3. Water pumps	SP
4. Sluice overflow pump	SP
5. Acid feed pump	SP
6. Wet ash handling equipment installation	SP

VIII. Spent Bed Materials Handling

1. Metering screw coolers	A
2. Spent bed makeup bins	A
3. Reinjection feeders	A
4. Makeup feeders	A
5. Bypass feeders	A

1f. Gaseous/Liquid Fuel Handling and Storage

IV. Fuel Handling and Storage

6. Fuel oil unloading station	0
7. Fuel oil tank and spill containment	0
8. Fuel oil heater	0
9. Pumping station	0

FIGURE 2-6
ALLOCATION OF COSTEAM EQUIPMENT ITEMS
TO ERA CAPITAL COST CATEGORIES
(CONTINUED)

1. GENERATING EQUIPMENT (Cont'd.)

1g. Coal Handling Systems

I. Major Boiler Equipment	
4. Pulverizers, primary air fans/drivers, air seal system	P
5. Coal feeders, scales	PS
14. Coal scales	
IV. Fuel Handling and Storage	
1. Unloading hoppers, bins, bunkers, conveyors, crushers, bucket elevator	SPA
2. Coal silo	SPA
3. Rail spur	SPA
5. Car thawer	SPA
IX. Coal and Limestone Handling	A
1. Coal feeders	A
2. Coal screw conveyor	A
3. Limestone feeder	A
4. Mixing conveyor	A
5. Elevator	A
6. Feeder bunker	A
7. Layer loader	A
8. Down spouts	A
9. Injection feeders	A
10. Injection piping and valves	A

1h. Other

II. Mechanical Equipment	
5. Valves and piping	SPAO
7. Utilities	SPAO
8. Building and supports, stairs, floors, siding, roofing, platforms	SPAO

3. AIR POLLUTION CONTROL EQUIPMENT

3a. Particulate Control

V. Flue Gas Cleanup and Handling	
1. Cyclone dust collector	SPO
2. Baghouse	SPAO
3. Electrostatic precipitator	SPO

FIGURE 2-6
ALLOCATION OF COSTEAM EQUIPMENT ITEMS
TO ERA CAPITAL COST CATEGORIES
(CONTINUED)

3. AIR POLLUTION CONTROL EQUIPMENT (Cont'd.)

3c. SO₂ Scrubber Components (Cont'd.)

V. Flue Gas Cleanup and Handling

4. Wet flue gas desulfurization; scrubber recycle pump/drive; scrubber make-up pump/drive; caustic injection system; slurry collection tank; caustic recycle tank	SPO
5. Dry flue gas desulfurization; limestone slaking and dust particulate collection and storage	SPO
6. Unloaders, hoppers, conveyors, crushers, bins, bunkers	SPAO
7. Limestone silo	SPAO
8. Limestone mixing tank	SPO

VII. Wet Ash Handling

7. Sludge dewatering	SPO
8. Sludge transport	SPO

4. WATER POLLUTION CONTROL EQUIPMENT

4a. Coal Storage Area Runoff

IV. Fuel Handling and Storage

4. Coal yard and drain system	SPA

4b. Pond

VII. Wet Ash Handling

9. Settling Pond	SPO

-
- A - AFB coal boiler
 - B - Selects wet or dry scrubber, or neither system, but not both using parameter GASCLEAN FSCRUB
 - C - Selects wet or dry ash handling, but not both using system parameter FWETA (CONVCOAL and CONVOIL)
 - D - Selects either settling pond or sludge dewatering and transport using parameter WETASH FDEWA
 - E - Selects either baghouse, precipitator, or neither system, but not both using parameter GASCLEAN FESP
 - H - For superheated steam only
 - P - Pulverized coal boiler
 - S - Stoker coal boiler
 - O - Oil fired boiler

FIGURE 2-6
ALLOCATION OF COSTEAM EQUIPMENT ITEMS
TO ERA CAPITAL COST CATEGORIES
(CONCLUDED)

3.0 COSTEAM MODEL STRUCTURE

At the end of Phase II of model development, COSTEAM consists of an executive program and 41 subroutines which read data files, conduct dialogue at the terminal, manipulate data and print results.

Three submodels calculate costs for conventional coal-fired boilers, AFB boilers and oil-fired boilers. Each of these three submodels consist of two subroutines: one subroutine calculates costs based on plant characteristics and equipment items selected, the other subroutine specifies the capital costs to be calculated and their storage location in the computer memory.

The executive program, subroutines, and data storage for COSTEAM are described below.

3.1 Executive Program

The Executive Program (EXEC) performs initialization functions and calls subroutines. Figure 3-1 is a flow diagram of the EXEC program. It also identifies the major subroutines and their functions. The subroutines read data files, conduct dialogue at the terminal, manipulate data, perform calculations and print results.

3.2 Subroutines

The subroutines which are required in the model are listed and described in Table 3-1. As shown, not all subroutines are called by the EXEC program. Some are called by other subroutines and, in turn, may call others. The last column in Table 3-1 defines the common areas in the working storage which are used by the subroutines.

FIGURE 3-1
MODEL FLOW

TABLE 3-1
MODEL SUBROUTINES

SUBROUTINE NAME	FUNCTION	CALLED BY	CALLS	COMMON AREAS
AFBC	Atmospheric fluidized bed coal submodel	EXEC	TAB, IA, OVER, INFLAT, FINANC, ERR, PERR, ZERO	PARM, SYSTEM, LOCAL, BASIC GLOB1, GLOB3, TABLE, ERROR
COLTIT	Print report column titles	PRINT		REPORT
CNCOAL	Conventional coal submodel	EXEC	TAB, IC, OVER, INFLAT, FINANC, ERR, PERR, ZERO	PARM, SYSTEM, LOCAL, BASIC, GLOB1, GLOB3, TABLE, ERROR
CNOIL	Conventional oil submodel	EXEC	TAB, IO, OVER, INFLAT, FINANC, ERR, PERR, ZERO	PARM, SYSTEM, LOCAL, BASIC, GLOB1, GLOB3, TABLE, ERROR
ERATIT	Print ERA report titles	REPERA		REPORT
ERAROW	Print ERA report rows	REPERA	PROW	REPORT
ERR	Record errors	CNCOAL, CNOIL, AFBC		ERROR
E215	Process format errors	ERRSET		CONTRO
ERRSET	IBM system error processing	EXEC	E215	
FINANC	Financial calculation	CNCOAL, CNOIL, AFBC		GLOB1,2,3, PARM, SYSTEM, BASIC
FORMAT	Calculate output formats	PROW		
G2CHNG	Control global type-2 changes	EXEC	GCHANG	BASIC, GLOB2, SYSTEM
GCHANG	Retrieve global price data	G2CHNG	TREADN	
IA	Calculate storage indices	AFBC		
IC	Calculate storage indices	CNCOAL		

TABLE 3-1 (Continued)

MODEL SUBROUTINES

SUBROUTINE NAME	FUNCTION	CALLED BY	CALLS	COMMON AREAS
INFLAT	Retrieve price escalation data	TAB, CNCOAL, CNOIL, AFBC		GLOB3, SYSTEM, BASIC
IO	Calculate storage indices	CNOIL		
OVER	Parameter value overrides	CNCOAL, CNOIL, AFBC		SYSTEM, PARM
PAGE	Print report page header	PRINT, REPERA		REPORT, SYSTEM, BASIC, CONTRO
PERR	Print error messages	CNCOAL, CNOIL, AFBC		ERROR, SYSTEM
PRICE	Retrieve global price data	TAB		GLOB3, SYSTEM, BASIC
PRINT	Print report contents	REPORTG	COLTIT, PAGE, PROW	REPORT
PRINTP	Print parameter values	REPORTG PSEARC		GLOB1,2,3. SYSTEM, PARM, REPORT
PROW	Print report rows	PRINT	FORMAT	REPORT
PSEARC	Find and override user specified parameters	REPORTG, READRD, REPGRA	PRINTP	GLOB1,2,3, PARM, SYSTEM
READC	Control component data reads	READS	READP, READT	SYSTEM
READB	Read basic operational inputs	EXEC	TREADN	BASIC, GLOB3
READG	Read global data file	EXEC		GLOB1, 2, 3
READP	Read system file parameters	READS, READC	TREADN	SYSTEM, PARM
READR	Control reading of report file	READS		SYSTEM
READRD	Read report file	REPORTG, REPERA	PSEARC	REPORT
READS	Control system file read	EXEC	READP, READV READR, READC	SYSTEM, PARM, LOCAL

TABLE 3-1 (Concluded)

MODEL SUBROUTINES

SUBROUTINE NAME	FUNCTION	CALLED BY	CALLS	COMMON AREAS
READT READV	Read component data tables Read system variant list	READC READS		SYSTEM
REPERA	Control ERA report generation	REPORG	ERAROW, ERATIT, READRD, PAGE, PSEARC	SYSTEM, LOCAL, REPORT, PARM
REPORG	Control report generation	EXEC	READRD, PRINT, PRINTP, REPERA	SYSTEM, REPORT
REPORU	Report user specified parameters	EXEC	PSEARC	SYSTEM
RTAB	Read table file data	TAB		TABLE
TAB	Table evaluation	CNCOAL, CNOIL, AFBC	RTAB, INFLAT, PRICE	TABLE, GLOB3, SYSTEM
TREADN	Read user terminal inputs	GCHANG, READB, READP		CONTRO
ZERO	Set capital costs to zero	CNCOAL, CNOIL, AFBC		PARM

Figure 3-2 presents graphically the control relationships of the subroutines described in Table 3-1. Values of output parameters are calculated by the technology submodels, subroutine TAB and subroutine FINANC.* Section 5.0 describes the AFB submodel and Section 6.0 describes the oil submodel.

Subroutine TAB serves two purposes in the extraction of COSTEAM tabular data. TAB first contains a routine for interpolation of data from steam tables. Secondly, TAB performs the primary COSTEAM capital cost calculations based on tables of reference plant cost data and scaling exponents.

The costs calculated by the technology submodel are estimates of the present costs of steam plant construction, operation and maintenance. After these costs have been calculated, the submodel calls subroutine FINANC. Subroutine FINANC escalates these costs to the plant start-up year. FINANC then calculates first year before- and after-tax costs and the annualized cost over the plant lifetime. Corresponding costs per thousand pounds of process steam are also calculated. Appendix B describes the equations in subroutine FINANC.

3.3 Data Organization

Data used by the model are classified as either global or system data. Model data are stored on five permanent files. To permit rapid

*See MTR79W00007-01 referred to earlier for the description of TAB, FINANC and the conventional coal submodel.

FIGURE 3-2
RELATIONSHIPS BETWEEN MODEL SUBROUTINES

access during the model operation, some of the data are temporarily stored in COMMON areas in the computer working memory.

3.3.1 Common Areas

Table 3-2 defines the common (COMMON) areas in the computer working storage. Adjacent to every COMMON area name are the descriptions of the storage contents and the subroutines which access that area.

Global data apply to all boiler plant technologies. They are obtained from the global file and from user inputs. The global file contains fuel characteristics, environmental parameters, financial parameters, regional prices of labor, and price indices of plant equipment and construction materials. Global data elements are listed in Table 3-3.

The basic global parameters are input by the user at the start of a run and are stored in the COMMON/BASIC/ area. Parameters from the global file that may be queried or overridden are stored in the GLOB1 and GLOB2 COMMON areas. Other global file data are stored in the GLOB3 COMMON area.

System data include operational parameter values, cost parameter values, labor and material factors, parameter names and storage indices. The system data also include table and report names. The table names are used by TAB to find data on the table file. The report names are used by the output subroutines to find report specifications on the report file. Portions of the system, table, error and report files are accessed for each steam production technology.

TABLE 3-2
COMMON AREAS

COMMON AREA NAME	CONTENTS	SUBROUTINES ACCESSING COMMON AREA
BASIC	Plant operating data input at start of run	FINANC, G2CHNG, INFLAT, PAGE, PRICE, READB, CNCOAL, CNOIL, AFBC
CONTRO	Program control data	E215, TREADN
GLOB1	Global File Type 1 Data --Parameter names and data values	FINANC, PRINTP, PSEARC, READG, CNCOAL, CNOIL, AFBC
GLOB2	Global File Type 2 Data --Parameter Group Names, parameter names and data values	FINANC, G2CHNG, PRINTP, PSEARC, READG
GLOB3	Global File Type 3 Data --Labor prices by region historic cost indices by year	FINANC, INFLAT, PRICE, PRINTP, PSEARC, READB, READG, TAB, CNCOAL, CNOIL, AFBC
LOCAL	Temporary storage of data values	CNCOAL, READ3, CNOIL, AFBC, REPERA
PARM	Parameter names, values, override values, component indexes from SYSTEM file and submodel calculations	CNCOAL, FINANC, OVER, PRINTP, PSEARC, READP, READS, ZERO, CNOIL, AFBC
REPORT	Report specifications from REPORT file	COLTIT, PAGE, PRINT, PRINTP, PROW, READRD, REPOG, REPERA, ERAROW, ERATIT
SYSTEM	System Control Data—from SYSTEM file and user inputs	CNCOAL, G2CHNG, FINANC, INFLAT, OVER, PAGE, PRICE, PRINTP, PSEARC, READC, READP, READR, READS, READT, REPOG, REPORU, TAB, CNOIL, AFBC
TABLE	Data from the TABLE file is stored for interpolation by subroutine TAB	CNCOAL, RTAB, TAB, CNOIL, AFBC
ERROR	List of error numbers for errors encountered in the submodel	ERR, PERR

TABLE 3-3

GLOBAL DATA

USER INPUTS	GLOBAL DATA FILE		
COMMON/BASIC/	COMMON/GLOB1/	COMMON/GLOB2/	COMMON/GLOB3/
Plant location Plant start-up date Steam characteristics <ul style="list-style-type: none"> - pounds per hour - pressure - temperature Operating characteristics <ul style="list-style-type: none"> - % condensate return - condensate return temp. - plant capacity factor 	Plant lifetime Prices <ul style="list-style-type: none"> - water - electricity - water treatment chemicals - scrubber chemicals - sludge disposal - dry ash disposal Rate of interest during construction Investment tax credit Income tax rate Rate of return on capital Factors for escalation beyond current year <ul style="list-style-type: none"> - capital costs - fuel costs - O & M labor - O & M materials 	Fuel characteristics for each fuel type <ul style="list-style-type: none"> - BTU/lb - ash % - sulfur % - moisture % - price Environmental standards <ul style="list-style-type: none"> - particulates (lb/10⁶ BTU) - NO_x (lb/10⁶ BTU) - SO₂ % removal - SO₂ ceiling (lb/10⁶ BTU) - SO₂ floor (lb/10⁶ BTU) 	List of valid regions List of valid years Yearly price indices of equipment and construction materials Regional prices of construction labor Regional prices of operating labor

The data elements specific to a steam technology are listed in Table 3-4. There are data on the system, table and report files for each technology submodel. All system file data values written into COMMON array PARM can be queried by the user during a terminal session. Parameter values calculated by the model are also stored in COMMON/ARM/ and can be queried.

Associated with each parameter name on the system data file is an override indicator. All parameter values in COMMON/ARM/ can be overridden by the user unless forbidden by the override indicator. Examples of parameters that cannot be overridden are those describing reference plant characteristics and some costs which are sums of other calculated costs.

In the technology submodel, parameter values stored in COMMON arrays are labeled by FORTRAN variable names. Model subroutines to query, report or change parameter values use eight-character parameter names.

The following is an example of the use of a parameter name: Suppose the system data file contains a value for boiler efficiency of 0.85. On the system data file among the data for component number 1, BOILER, would be the parameter name EFFBOIL, the value 0.85, and on index, say 1452. When the system data file is read, these data are stored in COMMON area ARM. ARM contains the arrays PNAME, V, VINP and INDEXC. The parameter name EFFBOIL would be stored as PNAME (1452), the value 0.85 as V(1452), component number (1) as INDEXC (1452). Prior to submodel calculations, the user could override the

TABLE 3-4
TECHNOLOGY SYSTEM DATA

USER INPUTS	SYSTEM DATA FILE		TABLE DATA FILE	REPORT DATA FILE	ERROR DATA FILE
COMMON/SYSTEM/	COMMON/SYSTEM/	COMMON/PARAM/	COMMON/TABLE/	COMMON/REPORT/	COMMON/ERROR/
Steam Technology	Report Names	Parameter Names and Values of:	Data Table Name	Report Name	List of errors encountered for current system
Variant Name	Component Name	Equipment selection flags	Table Type	Report Title	
Fuel Name	Table Names	Plant operating characteristics	Table Values	Row and Column Labels	Flag indicating error processing
Environmental Standard Name		Equipment Costs Construction Material Costs Construction Labor Costs Operating Costs		Parameter Names and Values	

parameter value by typing in BOILER EFFBOIL 0.84. The value 0.84 would be stored as VINP(1452) in common area PARM by subroutine PCHANG. To do this, PCHANG would search through array PNAME until it found a value of PNAME equal to EFFBOIL with a corresponding INDEXC equal to 1 (boiler). Before making submodel calculations using the boiler efficiency, subroutine OVER would replace the value of V(1452) by the value of VINP(1452). In the technology submodel, V(1452) in common area PARM is labeled BEFFIN, the FORTRAN variable name for boiler efficiency. After submodel calculations are completed, the value of the boiler efficiency could be retrieved for output. Subroutine PSEARC would search array PNAME until it found EFFBOIL with a corresponding INDEXC equal to 1. The value of V(1452)=0.84 would then be output.

3.3.2 Data Files

Table 3-5 lists the input/output units used by the model for data handling. Appendix C presents AFB capital cost data and scaling exponents, and Appendix D presents the oil and conventional coal capital cost data and scaling exponents. Appendix E shows the record formats of the files containing global, system, table, report and error data.

3.4 Reports

Table 3-6 lists all the reports which can be obtained from COSTEAM. The summary report automatically appears at the terminal when the run is completed.

The purpose of the summary report is to present general plant information without excessive printing time. From this general

TABLE 3-5
INPUT/OUTPUT UNITS

UNIT NUMBER	DESCRIPTION	RECORD LENGTH
1	Global File	80
2	System Data File	80
3	Report Specifications File	80
4	Output to User Terminal	120
5	Input from User Terminal	at least 40
6	High-Speed Printer	120
7	Table File	40
8	Error Message File	80

TABLE 3-6
OUTPUT REPORTS

REPORT NAME	REPORT CONTENTS
SUMMARY	Summary of capital costs, operating costs, financial calculations, environmental results
SUMCAP	Costs of purchased equipment, construction materials, construction labor, rented equipment for each of the plant components
CAPITAL	Costs of purchased equipment, construction materials, construction labor, rented equipment for each equipment item in each plant component
MATERIAL	Costs of construction materials and labor for each equipment item in each plant component
DESIGN	Fuel characteristics, plant operating characteristics, capital costs of environment-related items
OPERATE	Detailed operating costs
FINANCE	Parameters used in financial calculations, results of financial calculations
ERA	Capital costs in the format specified by Energy Regulatory Administration Form 318

information, the user will be able to detect quickly areas for further investigation and to query the computer for detailed costs.

The other reports are optional and can be printed at the terminal or at a high speed printer as desired by the user. The user can select report contents from the following three options: parameter values are reported; parameter names are reported; both the name and value of each parameter is reported. The options for including parameter names in the report can aid the user in overriding parameter values in subsequent runs.

In addition to the reports listed in Table 3-6, the user can also request a list of the names and values of all model parameters, or a list of the names and values of only those parameters he has input or overridden.

The specifications of each report are contained in the report data file. The names of the reports relevant to each steam production technology are contained in the system data file. Report contents can be changed or new reports added by changing these data files without changing and recompiling COSTEAM program coding.

3.5 Computer Requirements

COSTEAM runs require 512 thousand bytes of computer memory. COSTEAM source code is written in IBM FORTRAN IV (G1 compiler). The COSTEAM program uses the IBM extended error handling facility to

process typographical errors made at the terminal. The program also contains read statements of the form:

READ (i, *, END = J, ERR = K) list.

The COSTEAM source code and data are stored on permanent files in card-image format. The source code and data for the COSTEAM model with three submodels require the following amount of file space:

Source code (including comments)--8871 cards
Global data--239 cards
System data--1430 cards
Table data--4675 40-character record
Report specifications--3450 cards
Error message data--100 cards

The source code file includes 5106 cards of source code and comments for the three submodels: CNCOAL, CNOIL and AFBC (approximately 1700 cards each). Appendix F describes the COSTEAM files.

4.0 ATMOSPHERIC FLUIDIZED BED COSTING METHODOLOGY

The costing methodology for the AFB submodel parallels that of the conventional coal submodel developed during Phase I of this project. Section 4.1 describes the design assumptions of the reference AFB plants in the COSTEAM data files. Sections 4.2 and 4.3 describe the methodology used in the AFB submodel for calculating capital and operating costs.

Two AFB variants called "vendor" and "theory" are included in COSTEAM. They use different capital cost data for three equipment items: the AFB boiler (Major Boiler Equipment, item 1), the superheater and the bed materials cooler. Otherwise, the data and calculations are the same for both variants. The cost data for the "vendor" variant is based on manufacturer and vendor quotes. The "theory" variant contains lower costs for the three items mentioned above, representing estimates for a mature AFB technology. These estimates are developed in MITRE report MTR-80W00045.*

4.1 Description of Boiler Plant

The AFB submodel calculates capital and operating costs for industrial boilers ranging in size from 100,000 to 500,000 pounds of steam produced per hour. For submodel calculations, the major equipment items of the boiler plant have been grouped into eight components: major boiler equipment, mechanical equipment, instrumentation, coal handling, flue gas clean-up and handling, spent bed materials, and coal and limestone handling.

*MTR-80W00045, "Theoretical Cost Estimates for a Coal-Fired Atmospheric Fluidized Bed Boiler," the MITRE Corporation, March 1980.

Figure 2-4 listed the equipment items in each group for all three steam production technologies. The same grouping and numbering of equipment items is used by all submodels. This convention enables the user to easily query or change the same parameters for different steam production technologies during a session at the computer terminal.

Figure 4-1 lists those equipment items that are part of the AFB boiler plant. With the exception of major boiler equipment, spent bed materials handling and coal and limestone handling, the capital costs of equipment items in the AFB plant are either equal to or multiples of the cost of the same item in a conventional pulverized coal fired boiler plant.

Appendix A provides additional data on the equipment items. Where similar equipment is required for the AFB plant and for the conventional coal-fired plant, the AFB equipment items are assumed to be the same in capacity factor, redundancy and materials to those in a conventional coal-fired plant. Appendix B lists the AFB capital cost data in the model and the data sources.

The COSTEAM capital cost estimates for conventional coal and oil-fired boilers should be accurate to ± 15 -20 percent. For the AFB, the total capital cost should be accurate to ± 25 percent.

I. MAJOR BOILER EQUIPMENT	BOILER*
1. Tubes, drums, headers, casing access doors, windbox ash hopper, ash reinjection	
2. Oil ignition system	
3. Booster fan	
4. Superheater ^H	
5. F.D. fan/drive	
6. Tubular air heater	
7. Economizer	
8. Direct-fired air heater	

II. TECHNICAL EQUIPMENT	MECHANIC*
1. Desuperheater/reducing station ^H	
2. Feedwater softeners, dealkalizers, blowdown system, deaerators & accessories	
3. Boiler feed pumps/drives	
4. Feedwater heater	
5. Valves and piping	
6. Steam coil air preheater	
7. Utilities	
8. Building and supports, stairs, floors, siding, roofing, platforms	

III. BOILER INSTRUMENTS	INSTRUM*
1. Feedwater control	
2. Compressed air system	
3. Control room	
4. Fuel control	
5. Combustion control	
6. Burner management	
7. Instrument installation	

IV. FUEL HANDLING AND STORAGE	FUELHAND*
1. Unloading hoppers, bins, bunkers, conveyors, crushers, bucket elevator	
2. Coal silo	
3. Rail spur	
4. Coal yard and drain system	
5. Car trower	

V. FLUE GAS CLEANUP AND HANDLING	GASCLEAN*
1. Cyclone dust collector	
2. Baghouse ^E	
3. Electrostatic precipitator ^E	
4. Limestone crusher	
5. Lime/limestone unloaders, conveyors, silo, bins, bunkers	
6. I.D. fan/drive/coupling	
7. Stack	

VI. DRY ASH HANDLING	DRYASH*
1. Ash silo and accessories	
2. Ejector	
3. Separator	
4. Air washer	
5. Valves/pipes	
6. Ash transport and disposal equipment	
7. Dry ash handling equipment installation	

**FIGURE 4-1
AFB PLANT COMPONENTS AND EQUIPMENT ITEMS**

VIII. SPENT BED MATERIALS HANDLING	SPENTBED
1. Metering screw coolers	
2. Spent bed makeup bins	
3. Reinjection feeders	
4. Makeup feeders	
5. Bypass feeders	

IX. COAL & LIMESTONE HANDLING	AFBMATS
1. Coal feeders	
2. Coal screw conveyor	
3. Limestone feeder	
4. Mixing conveyor	
5. Elevator	
6. Feeder bunker	
7. Layer loader	
8. Down spouts	
9. Injection feeders	
10. Injection piping and valves	

* - Computer code name
 E - Selects either baghouse, precipitator, or neither system using parameter GASCLEAN ESP. The default value is GASCLEAN ESP = 0, which selects the baghouse.
 H - For superheated steam only

FIGURE 4-1
AFB PLANT COMPONENTS AND EQUIPMENT ITEMS
(CONCLUDED)

4.2 Capital Cost Calculations

The capital costs associated with each equipment item in the AFB plant are calculated in the same way that calculations are made for the conventional coal plant. For each equipment item, 11 capital costs can be calculated by the model: purchased equipment, six kinds of contractor-furnished materials, three kinds of construction labor and construction equipment rental. These cost categories are listed in Table 4-1.

The capability for calculation of capital costs at this level of detail (57 equipment items times 11 capital costs) is included so that the user can make detailed adjustments via cost overrides to reflect existing equipment at his plant, or new equipment prices he has obtained from vendors.

The following additional capital cost components are calculated as a fraction of the total capital cost for the seven equipment components: engineering and architecture, fees construction management, and contingency costs. The cost of the coal stockpile is calculated from the coal price, coal consumption rate and the number of days of coal reserves required. An additional capital cost CEXTRA, which is zero unless overridden, is included to allow the user to add unique site-specific costs not calculated by COSTEAM. The cost of interest during construction is calculated using the sum of the above costs, the interest rate and the time required for plant construction. Working capital is calculated as a function of annual operating, maintenance and fuel costs.

TABLE 4-1

CAPITAL COST CATEGORIES

- 1 Purchased Equipment Items
- 2 Mechanical Materials
- 3 Structural Materials
- 4 Instrumentation Materials
- 5 Insulation Materials
- 6 Civil Construction Materials
- 7 Electrical Materials
- 8 Unskilled Construction Labor
- 9 Skilled Labor (Steamfitters)
- 10 Skilled Labor (Electrician)
- 11 Rented Construction Equipment

Capital cost for an individual equipment item of a given size is calculated by exponentially scaling the cost of a similar equipment item in a reference plant to the size of the item of interest. Adjustments are made for coal characteristics, plant operating characteristics, plant location and year of plant construction. Reference plants of three different sizes are used to improve model accuracy. The reference plant sizes are 100,000, 200,000 and 400,000 pounds per hour of steam production capacity. Reference plant costs apply to a plant located in the Atlanta, GA region.

When the reference cost data are not for the current year, national price indices are used to update the capital costs. This use of price indices makes yearly changes of large amounts of cost data unnecessary and allows comparisons among steam technologies whose cost bases are for different years. With few exceptions, the equipment items and construction materials do not have to be purchased locally. Therefore, yearly national indices* are stored as global data and are used to escalate prices of equipment and construction materials. The Engineering News Record publishes the wage rates for construction labor in 20 U.S. cities. The current wage rates for unskilled heavy construction workers, electricians and steamfitters are stored in the global data file. These wage rates serve to compute the current cost of construction labor.

The general equation for calculating the Kth capital cost of the Jth equipment item of the Ith boiler component is as follows:

$$COST = G_{IJK} A_{IJK} (F_{IJK} X/S(I))^{B_{IJK}} H_{rK} E_{tIJK}$$

where

A_{IJK} = cost of reference plant equipment item

B_{IJK} = scaling exponent

X = boiler size required to meet steam demand

$S(I)$ = boiler size of reference plant

F_{IJK} = size correction factor for coal ash content and coal heat content

G_{IJK} = cost correction factor for superheat-- applied only if superheat is required

H_{rK} = regional wage rate - applied only to labor costs ($K = 8, 9, 10$)

E_{tIJK} = ratio of price indices - applied to equipment and material costs ($K \neq 8, 9, 10$)

4.3 Operating Cost Calculations

The annual operating costs of an AFB plant include costs of fuel, electricity, water, waste disposal, limestone, water treatment chemicals, maintenance materials and labor. The methods for calculating each of these costs are described below.

*Such as Bureau of Labor Statistics Producer Price Indices and the Chemical Engineering Chemical Plant Indices. Phase II data contain only Chemical Engineering Chemical Plant Indices.

The annual fuel cost is calculated in the following steps:

1. The heat input required per pound of process steam is calculated from steam conditions and condensate characteristics.
2. The heat released per ton of coal burned is calculated from the coal high heat value and moisture content.
3. The boiler efficiency is obtained from the system data file.*
4. The annual fuel cost formula is as follows:

ANNUAL FUEL COST =

$$\frac{(\text{heat input per lb of steam}) (\text{lbs of steam per hour})}{(\text{heat release per ton of coal}) (\text{boiler efficiency})} \\ \times (\text{plant capacity factor}) (8760 \text{ hours per year}) \\ \times (\text{price per ton of coal})$$

The annual electricity cost is the product of electricity demand in kilowatt-hours, the cost per kilowatt-hour and the number of hours of operation per year. The total electricity requirements of the particulate removal equipment and of the balance of the plant represent the electricity demand.

The electricity requirement for the balance of the plant is calculated by multiplying the steam demand by a constant, which can be overridden. An additional multiplying factor is included for high pressure (superheated) steam. The electricity required by

*The boiler efficiency depends on boiler type, fuel characteristics, operating conditions and the presence of heat recovery equipment such as an economizer and/or air preheater. The system data file contains a boiler efficiency value of 0.85, which can be overridden.

the baghouse equals a constant times the product of the pressure drop across the baghouse and the actual cubic feet per minute of flue gas divided by the total efficiency of the fan system. The electricity required by the electrostatic precipitator equals a constant times the size of the area of the collecting electrode. The collecting electrode area is calculated as a function of the fraction of particulates removed, the sulfur in the flue gas and the actual cubic feet per minute of flue gas.

The annual cost for limestone is the product of the amount used per hour, the cost per pound and the hours of plant operation per year. The amount of limestone per hour is calculated from the coal firing rate, sulfur content of the coal and the ratio of number of moles of calcium required per mole of sulfur in the coal. The calcium to sulfur molar ratio is a system parameter with a default value of 3.

The amount of boiler feedwater required equals the steam demand of the boiler minus the amount of condensate return. The cost of water treatment chemicals is proportional to the amount of feedwater used. Waste disposal cost is based on a fixed cost per ton of solid waste. The solid waste calculations are described in Section 5.1.

For each boiler component, annual maintenance material costs are calculated as a fraction of component capital cost. Maintenance costs for particulate removal equipment are computed separately from the rest of the equipment in the flue-gas-handling component of the plant. If a baghouse is used, the cost of bags is an additional maintenance

cost. The annual cost of bags is equal to a constant times the actual cubic feet per minute of flue gas.

Operating and maintenance labor is a function of boiler size and capacity factor. Table 4-2 lists the six categories of operating and maintenance labor, and the number of workers required in each category. Wage rates for each category for each region are stored in the global data file. The numbers of workers and their hourly wages can be overridden by the user. The annual cost of insurance and property tax is a fraction of plant capital cost.

TABLE 4-2
AFB OPERATING LABOR REQUIREMENTS

Labor Category	REFERENCE BOILER SIZE (LE/HR)					
	100,000		200,000		400,000	
	Number of Workers Required	Total Number of Hours per Week	Number of Workers Required	Total Number of Hours per Week	Number of Workers Required	Total Number of Hours per Week
1. Senior Operator	4*	160	4*	160	4*	160
2. Assistant Operator	4	160	4	160	4	160
3. Maintenance Mechanic	1	40	1	40	2	80
4. Equipment Operator	1	40	1	40	2	80
5. Plant Superintendent	0	0	1	40	1	40
6. Unskilled Labor	0	0	1	40	2	80

* One additional worker is added when plant capacity factor exceeds .57.

5.0 ATMOSPHERIC FLUIDIZED BED SUBMODEL

The atmospheric fluidized bed (AFB) submodel calculates the costs associated with boilers burning coal in a fluidized bed at atmospheric pressure supplemented with particulate removal equipment. The major results calculated in the submodel are the capital costs of purchased equipment and plant construction and the annual costs of fuel, operation and maintenance.

The AFB submodel consists of two subroutines: AFBC, which calculates operating characteristics, capital costs and operating costs, and the function subroutine IA which calculates storage indices for the capital costs. These subroutines perform the same kinds of calculations that subroutines CNCOAL and IC perform for conventional coal-fired boilers.

The structure of subroutine AFBC is shown in Figure 5-1. The following paragraphs summarize the calculations performed in each step shown in the figure.

Step 1: Subroutine AFBC is called by the EXEC program after the system data have been read in and parameter overrides have been completed.

Step 2: The existence of optional equipment items is specified by user inputs indicating superheated steam, type of particulate removal equipment and dry ash handling. Subroutine ERR is called to record warning messages. ERR is called if the user has selected a combination of equipment items that are not consistent with a complete

FIGURE 5-1
STRUCTURE OF SUBROUTINE AFBC

plant design or that fail to match fuel characteristics or environmental standards.

Step 3: Plant operating characteristics depend on the basic operational data input by the user, fuel characteristics and environmental regulations. The boiler size is determined from steam and condensate characteristics, and flow rates are calculated for coal, air, ash, SO₂ and flue gas particulates. Section 5.1 describes this step in greater detail. Subroutine ERR is called to record warning messages if plant operating characteristics are not in agreement with environmental standards or if parameter overrides are inconsistent with calculated values.

Step 4: The size of some equipment items depends on the quantity of materials handled. Correction factors for equipment to handle coal, limestone and spent bed materials equal the ratios of the quantity of materials handled to the quantity handled in the reference plant.

Step 5: Subroutine PERR is called to print at the terminal the warning messages recorded in Steps 2 and 3. After the warning messages are printed, the user has three options:

1. The user can continue the run. Control returns to Step 6 of the AFB submodel.

2. The user can change parameter values. After the changes have been made, control returns to Step 1 and AFB calculations are begun anew.
3. The user can stop the COSTEAM run.

Step 6: The capital costs associated with each equipment item in each boiler plant component are calculated.

Subtotals by equipment item, component and cost type are also calculated. Section 5.2 describes this step in greater detail.

Step 7: In this step, plant operating characteristics are used to calculate the cost of fuel, water and electricity consumption, operating and maintenance materials and labor. Annual operating costs and costs per thousand pounds of process steam are derived. Section 5.3 contains a flow diagram of this step.

Step 8: The total capital costs and annual operating costs are used in subroutine FINANC to calculate the lifetime plant costs, the total annualized costs, and the cost per pound of steam produced.

Step 9: Control returns to the EXEC program which then calls REPORG to produce a summary report at the terminal. The EXEC then conducts a dialog with the user at the computer terminal to display calculated values, print detailed reports, rerun with different inputs and/or end the terminal session.

5.1 Operating Characteristics

Plant operating characteristics are used as inputs to capital and operating cost calculations. Figure 5-2 is a flow chart of the portion of subroutine AFBC that calculates the operating characteristics. The following paragraphs summarize the calculations performed in the steps shown in that figure. Steps 1, 2 and 3 are the same for both AFB and conventional coal fired boilers.

Step 1: Calculation of operating characteristics is begun after equipment items have been specified by user inputs.

Step 2: Subroutine TAB is called to obtain the enthalpy (heat content) and temperature of saturated steam corresponding to the steam pressure specified by the model user. If superheated steam has been specified, TAB returns the enthalpy value corresponding to the specified pressure and temperature.

Step 3: The enthalpy of the boiler feedwater is calculated from the temperature of the make-up water, the temperature of the condensate return and the condensate return and the fraction of process steam returned as condensate. The heat input required per pound of process steam is the enthalpy of the steam minus the enthalpy of the feedwater. A portion of the steam produced by the boiler is used in the deaerator to heat the boiler feedwater to the boiler inlet temperature. The deaerator steam requirement is calculated from the

STEP

1

BEGIN CALCULATING
PLANT OPERATING CHARACTERISTICS

2

CALL SUBROUTINE "TAB"
OBTAIN STEAM ENTHALPY
OBTAIN SATURATION TEMPERATURE

3

CALCULATE BOILER SIZE

4

CALCULATE COAL, AIR, FLY ASH
FLOW RATES

5

CALCULATE LIMESTONE, SPENT BED
MATERIALS FLOW RATES

6

PARTICULATE REMOVAL
CALCULATIONS

7

END OF OPERATING
CHARACTERISTICS CALCULATIONS

FIGURE 5-2
CALCULATION OF OPERATING CHARACTERISTICS

process steam demand and enthalpies of the feedwater, inlet water and the steam. The boiler size (pounds of steam per hour) is the sum of the process steam demand and the deaerator steam requirement.

Step 4: The heat released per ton of coal burned is calculated from the coal high heat value and moisture content. The boiler efficiency is obtained from the system data file.* The tons of coal required per hour is the product of the heat input required per pound of steam and the steam demand (pounds of steam per hour) divided by the product of boiler efficiency and the heat released per ton of coal burned.

The flow of flue gas (actual cubic feet per minute) depends on the tons of coal burned per hour, the flue gas temperature and the excess air fraction. The ash production rate is the product of the coal firing rate and the percentage ash in the coal divided by one hundred. Coal and ash flow rates per million Btu fired are also calculated. Ash is removed from the AFB with the spent bed materials. Fly ash is captured by the mechanical collector and reinjected into the bed, and

*The boiler efficiency depends on boiler design, operating conditions and the presence of heat recovery equipment such as an air preheater and/or an economizer. The system data file contains a boiler efficiency value of .85 which includes the effects of heat recovery equipment. This value can be overridden by the user.

collected by the particulate removal equipment (ESP or baghouse).

The model assumes that the AFB is designed to remove a fraction of the SO₂ sufficient to meet the environmental standard. The environmental standard ceiling for SO₂ is expressed in pounds of SO₂ per million Btu of fuel burned. A percentage SO₂ removal requirement is also specified. From the standard and the coal firing rate, the model calculates the pounds of SO₂ emitted per hour.

The model also assumes that the particulate removal equipment will meet the environmental standard for particulates, expressed as pounds of particulates per million Btu fired. From the standard and the coal firing rate, the model calculates the pounds of particulates emitted per hour.

Since the bed temperature is around 1550°F, it is assumed that the AFB coal boiler will meet the environmental standard for NO_x. No calculations of NO_x emissions are made in the model.

Step 5: The amount of calcium required in the bed is calculated from the following formula:

$$\text{Ca (lb/hr)} = (\text{coal firing rate [lb/hr]}) \times \left(\frac{\% \text{ S in coal}}{100} \right) \\ * \left(\frac{40}{32} \right) * \left(\frac{\text{Ca}}{\text{S}} \text{ molar ratio} \right)$$

where 40/32 is the ratio of the molecular weight of calcium to the molecular weight of sulfur. The calcium to sulfur molar ratio is an input parameter to the model with a default value of 3.

The limestone feed rate is calculated from the following formula:

$$\text{Limestone (lb/hr)} = \text{Ca (lb/hr)} * \left(\frac{100}{40} \right) * \left(\frac{1}{1-\text{FI}} \right)$$

where 100/40 is the ratio of the molecular weight of CaCO_3 to the molecular weight of Ca and FI is the inert fraction of the limestone.

Step 6: The amount of solid waste produced by the AFB affects disposal costs as well as the size and cost of ash handling equipment. The solid waste produced is the sum of: ash, unburned carbon, sulfur in the ash, CaSO_4 from reaction of sulfur in the coal with limestone, unreacted CaCO_3 removed from the bed and inert bed materials.

The ash flow rate was calculated in Step 4. It is assumed that unburned carbon is removed from the flue gas and reinjected so that it is a negligible fraction of the solid waste.

The flow rates (lb/hr) of the other materials are calculated in the following way:

$$\text{Sulfur in ash} = \text{coal feed rate} * \left(\frac{\% \text{ S in coal}}{100} \right) * FS$$

where FS is the fraction of sulfur trapped in ash particles.

$$\begin{aligned} \text{Sulfur in CaSO}_4 &= \text{coal feed rate} * \left(\frac{\% \text{ S in coal}}{100} \right) \\ &\quad - \text{sulfur in ash} \\ &\quad - \text{SO}_2 \text{ emissions} * \left(\frac{32}{64} \right) \end{aligned}$$

where the SO₂ emissions were calculated in Step 5 from the environmental standard and the coal firing rate.

$$\text{CaSO}_4 = \text{Sulfur in CaSO}_4 * \left(\frac{136}{32} \right)$$

$$\text{Ca in CaSO}_4 = \text{Sulfur in CaSO}_4 * \left(\frac{40}{32} \right)$$

$$\text{Unreacted CaCO}_3 = \left[\text{Ca feed rate} - \text{Ca in CaSO}_4 \right] * \left(\frac{100}{40} \right)$$

removed from bed.

where the calcium feed rate is as calculated in Step 6.

$$\text{Insert bed materials} = \text{limestone flow rate} * FI$$

where the limestone flow rate is as calculated in Step 6 and FI is the inert fraction of the limestone.

Step 7: Control passes to the next section of AFBC, which calculates capital cost correction factors for coal low heat value and ash content.

5.2 Capital Cost

The capital costs calculated in subroutine AFBC are listed in Figure 5-3. The conventional coal and oil submodels calculate capital costs for the same categories. For some components, construction materials and equipment rental costs cannot be meaningfully subdivided among equipment items. When this occurs, total costs are calculated for several items as a whole by scaling total reference plant costs. These cases are also indicated in Figure 5-3.

Figure 5-4 is a flow chart of the capital cost portion of subroutine AFBC. The flow is the same for the capital cost portions conventional coal and oil submodels. The following paragraphs summarize the calculations performed in the steps shown in that figure.

Step 1: Capital cost indices are as follows: I indicates plant component (I = 1 to 9); J indicates equipment item (J = 1 to a maximum of 40); K indicates cost category (K = 1 to 11). The costs are calculated for all allowable values of indices I, J and K.

Step 2: Capital costs are stored in COMMON/PARM in storage location CAPCST(IX). The function IA (I,J,K) calculates the storage index IX using the values of I, J, and K and a MAP array defined by data statements in

CAPITAL COST CATEGORY	BOILER PLANT COMPONENTS							SPENT** MATS. 8	FEED** SYST. 9
	MAJOR BOILER 1	MECH. EQUIP. 2	INSTR. 3	FUEL HANDL. 4	FLUE GAS 5	DRY ASH 6	WET* ASH 7		
1 PURCHASED EQUIPMENT	J	J	J	I	J	J	J	J	J
2 MECHANICAL MATERIALS	J	J	-	-	J	I	I	J	I
3 STRUCTURAL MATERIALS	J	J	-	I	J	I	I	J	J
4 INSTRUMENTATION MATERIALS	J	J	I	-	J	-	-	-	J
5 INSULATION MATERIALS	J	J	-	-	J	-	-	-	J
6 CIVIL MATERIALS	J	J	-	I	J	I	I	-	J
7 ELECTRICAL MATERIALS	J	J	I	I	J	I	I	J	J
8 UNSKILLED LABOR	J	J	-	I	J	I	I	J	J
9 SKILLED LABOR (STEAMFITTER)	J	J	I	I	J	I	I	J	J
10 SKILLED LABOR (ELECTRICIAN)	J	J	I	I	J	I	I	J	J
11 RENTED CONSTRUCTION EQUIPMENT	J	J	-	I	J	I	I	J	J

I=calculated cost applies to several equipment items
 J=cost calculated for each equipment item
 -=negligable cost, set to zero
 * Used only by conventional coal and oil submodels
 ** Used only by AFB submodel

FIGURE 5-3
 CAPITAL COSTS CALCULATED IN SUBMODEL

STEP

1

2

3

4

5

6

**FIGURE 5-4
CAPITAL COST CALCULATIONS**

FIGURE 5-4
CAPITAL COST CALCULATIONS (CONCLUDED)

the program. The use of this indexing procedure avoids the assignment of blocks of COMMON storage area for costs which are not calculated.

Step 3: A particular capital cost is not calculated if the function IA (I,J,K) returns a value of zero, indicating that no storage location exists for this cost. Also, the capital costs for an equipment item are not calculated if user inputs have specified that this equipment is not included in the boiler plant design under consideration.

Step 4: The size parameter X1 is the product of the boiler size and the correction factor for material flow rate divided by the reference plant boiler size.

Step 5: Subroutine TAB calculates the capital cost in the following manner:

$$\text{RESULT (J,K)} = (A_{IJK}(X1))^{B_{IJK}} (H_{rk})$$

Before subroutine TAB performs this calculation, subroutine RTAB is called by TAB to store values of A_{IJK} and B_{IJK} into COMMON/TABLE/. Factor H_{rk}, the regional price of construction labor, is applied only when K equals 8, 9 or 10.

Step 6: The cost of feedwater treatment equipment items and boiler feed pumps and drives is increased by a multiplicative factor of 1.5 if superheated steam is

produced. This factor reflects changes in design and materials requirements for high pressure and purity. The reference plant cost for the boiler tubes, drums, etc. (item 1 of Major Boiler Equipment) is for a boiler producing 925 psig steam at 900°F. For boilers smaller than 300,000 lb/hr producing saturated steam, the purchased equipment cost for the boiler tubes, drums, etc., is reduced by 1/1.3. This reflects the reduced design and materials requirements due to lower temperatures and processes.

Step 7: Subroutine INFLAT is called to escalate the cost of equipment and materials calculated by subroutine TAB to current year prices. Data statements in AFBC contain the name of the price index used for each cost.

Step 8: The user may already have equipment, e.g., feedwater treatment facilities, installed in his plant. Thus he may have input a total capital cost of zero for that item. Subroutine ZERO sets all of the capital costs for that equipment item to zero.

Step 9: After all of the capital costs have been calculated for a component, subroutine OVER is called to replace calculated costs with user input values. This capability allows the user to input known capital costs for equipment items.

Step 10: Costs are summed to obtain the total capital cost for each equipment item and for the component. The total component costs of construction labor and materials are also calculated.

Step 11: After the sum of the capital costs of all eight boiler plant components has been calculated, the following are calculated as fractions of that sum: cost of engineering and architecture services, cost of construction management, and contingency cost. The cost of the coal stockpile is also calculated. CEXTRA, an additional capital cost which is zero unless overridden by the user, is added to the sum of the above costs. The cost of interest during construction is calculated from this sum based on the following: the number of years required for plant construction is a system level parameter which can be overridden; the fraction of the total capital required during each year is specified in data statements in subroutine CNCOAL; the interest rate during construction is a global parameter; capital costs are not escalated during the construction period; all money is borrowed at the start of the year during which it is required.

Step 12: After completing the capital cost calculations, the operating costs are calculated. These are discussed in

the next section. At the end of the operating cost calculations, the working capital is calculated and added to the total capital cost. Working capital equals fraction WCAPF times the annual cost for operation, maintenance and fuel.

5.3 Operating Costs

The sequence of operating cost calculations is shown in Figure 5-5. Plant operating characteristics and prices of consumables are used to calculate annual operating costs, and average costs per thousand pounds of process steam are calculated. Also calculated are quantities of consumables used per hour at full capacity and quantities used per day and per year at the plant capacity factor.

Since the industrial user may have data on annual operating expenses at similar plants, the annual operating costs can be overridden. When this occurs, the price of the consumable is ignored and the cost per thousand pounds of steam is made compatible with the annual cost. After the operating costs have been calculated, subroutine FINANC calculates total capital and operating costs from the current year to the plant start-up year, and annualized lifetime cost of steam production. After financial calculations are completed, control returns to the EXEC program. EXEC then calls the report generating subroutines.

FIGURE 5-5
OPERATING COST CALCULATIONS

6.0 OIL SUBMODEL

The oil submodel calculates the capital and annual costs for industrial steam plants burning number 6 fuel oil. The plants include flue gas cleanup and particulate removal equipment. The organization of the data base and the logic of the oil submodel parallels those for the conventional coal and AFB submodels. Section 6.1 lists the costs calculated for the oil-fired boiler plant. Section 6.2 discusses the structure of the oil submodel.

6.1 Description of Boiler Plant

The oil submodel calculates capital and operating costs for industrial boiler plants producing from 50,000 to 500,000 pounds of steam per hour. The seven components of the oil fired plant and the equipment items in each plant are listed in Figure 6-1.

With the exception of the major boiler equipment and the fuel handling and storage facilities, the capital costs of the equipment items in the oil-fired plant are equal to or fractions of the cost of that same item in a conventional coal-fired boiler plant. The 100,000 and 200,000 lb/hr oil-fired boilers are shop-fabricated. The 400,000 lb/hr boiler is field-erected. Appendices A and C contain additional information on the oil-fired boiler equipment and reference plant costs.

The oil submodel calculates eleven capital costs for each equipment item. In addition, it also calculates the following capital costs: engineering and architecture fees, construction management

I. MAJOR BOILER EQUIPMENT	BOILER*
1. Tubes, drums, headers, casing access doors, windbox, ash hopper, ducts, burners, economizer or air heater, soot blowers, flame failure detection, support steel, gratings, forced draft fan and drive	
7. Superheater ^H	

III. BOILER INSTRUMENTS	INSTRUM*
2. Feedwater control	
4. Compressed air system	
9. Control panel	
10. Instrument installation	

V. FLUE GAS CLEANUP AND HANDLING	GASCLEAN*
1. Cyclone dust collector	
2. Baghouse ^A	
3. Electrostatic precipitator ^A	
4. Wet flue gas desulfurization scrubber recycle pump/drive scrubber make-up pump/drive caustic injection system slurry collection tank ^B caustic recycle tank	
5. Dry flue gas desulfurization lime slaking and dust particulate collection and storage ^B	
6. Limestone crusher	
7. Lime/limestone unloaders, conveyors, silo, bins, bunkers	
8. Lime/limestone mixing tank	
9. I.D. fan/drive/coupling	
10. Stack	

II. MECHANICAL EQUIPMENT	MECHANIC*
1. Desuperheater/reducing station ^H	
2. Feedwater softeners, dealkalizers, blowdown system, deaerators & accessories	
3. Boiler feed pumps/drives	
4. Feedwater heater	
5. Valves and piping	
6. Steam coil air preheater	
7. Utilities	
8. Building and supports, stairs, floors, siding, roofing, platforms	

IV. FUEL HANDLING AND STORAGE	FUELHAND*
6. Fuel oil unloading station	
7. Fuel oil tank and spill containment	
8. Fuel oil heater	
9. Pumping station	

VI. DRY ASH HANDLING ^C	DRYASH*
6. Transport and disposal equipment for dry scrubber waste	

VII. WET ASH HANDLING ^C	WETASH*
7. Sludge dewatering ^D	
8. Sludge transport ^D	
9. Settling pond ^D	

- * Computer code name
A - Selects either baghouse, precipitator, or neither system, but not both using parameter GASCLEAN FESP
B - Selects wet or dry sulfur removal, or neither system, but not both using parameter GASCLEAN FSCRUB
C - Selects wet or dry ash handling, but not both using system parameter FWETA
D - Selects either settling pond or sludge dewatering and transport using parameter WETASH FDEWA
H - For superheated steam only

**FIGURE 6-1
CONVENTIONAL OIL-FIRED BOILER PLANT COMPONENTS AND EQUIPMENT ITEMS**

fee, contingency cost, fuel stockpile, interest during construction and working capital. The calculation method is the same as for the coal-fired plants.

The annual operating costs of an oil-fired plant include costs of fuel, electricity, water waste disposal, scrubber chemicals, water treatment chemicals, insurance, maintenance materials and operating and maintenance labor. The methods for calculating each of these costs parallel those for the conventional coal-fired boilers. Table 6-1 lists the number of workers required for operation and maintenance of the oil-fired plant. As with the other submodels, the numbers of workers and their hourly wages may be overridden by the COSTEAM user.

6.2 Submodel Calculations

The oil submodel consists of two subroutines: CNOIL, which calculates operating characteristics, capital costs and operating costs, and the function subroutine IO which calculates storage indices for the capital costs.

The structure of subroutine CNOIL parallels that of subroutine AFBC, discussed in Section 5.0. Equipment items are selected; operating characteristics and capital cost correction factors are calculated; capital costs are calculated using reference plant costs, scaling factors and correction factors; operating costs are calculated; subroutine FINANC is called to calculate annualized costs.

TABLE 6-1

OIL-FIRED BOILER PLANT OPERATING LABOR REQUIREMENTS

Labor Category	REFERENCE BOILER SIZE (LB/HR)					
	100,000		200,000		400,000	
	Number of Workers Required	Total Number of Hours per Week	Number of Workers Required	Total Number of Hours per Week	Number of Workers Required	Total Number of Hours per Week
1. Senior Operator	2*	160	2*	160	2*	160
2. Assistant Operator	2	160	2	160	2	160
3. Maintenance Mechanic	1	40	1	40	1	80
4. Equipment Operator	1	40	1	40	1	80
5. Plant Superinten- dent	0	0	1	40	1	40
6. Unskilled labor	0	0	1	40	1	80

* One additional worker is added when plant capacity factor exceeds .57.

The capital and operating cost calculations in CNOIL are the same as those for CNCOAL, except that the fuel characteristics are those of number 6 fuel oil rather than coal. CNOIL uses the conventional coal reference plant data for flue gas cleanup and handling and scrubber waste transport and disposal. A correction factor is applied when calculating purchased equipment costs for particulate removal, fans and scrubbers. This factor equals the ratio of the amount of flue gas (actual cubic feet per minute) in the oil-fired plant to the amount of flue gas in a coal-fired plant of the same size.

7.0 COSTEAM RESULTS

The tables in this section summarize the results of four COSTEAM Model runs. These results are for boilers producing 200,000 pounds of 250 PSIG saturated steam per hour. The boiler plants are located in the Chicago region. The capital cost for the "Vendor" variant AFB is higher than the cost of the other boilers because of the high costs of the major boiler equipment, equipment for coal and limestone feed and spent bed materials handling. However, because of the high cost of oil relative to coal, the total annual costs for coal-fired boilers (AFB's and pulverized coal) are less than the total annual cost for an oil fired boiler.

TABLE 7-1

CAPITAL COST COMPARISONS PRELIMINARY COSTEAM DATA
200,000 LB/HR PROCESS STEAM*

PLANT COMPONENT	ANNUAL OPERATING COSTS (\$198C MILLIONS)			
	CONVENTIONAL PULVERIZED COAL BOILER WITH WET SCRUBBER	ATMOSPHERIC FLUIDIZED BED (VENDOR)	ATMOSPHERIC FLUIDIZED BED (THEORY)	CONVENTIONAL OIL-FIRED BOILER WITH WET SCRUBBER
Major Boiler Equipment	3.90	7.08	2.59	1.31
Mechanical Equipment	1.68	1.63	1.63	1.49
Boiler Instruments	0.50	0.50	0.50	0.17
Fuel Handling and Storage	0.82	0.81	0.81	1.05
Flue Gas Cleanup and Handling	2.11	1.24	1.24	0.27
Dry Ash Handling	0.39	1.22	1.22	-
Sludge Dewatering and Transport	0.30	-	-	-
Spent AFB Bed Material Handling	-	0.36	0.14	-
AFB Coal and Limestone Feed	-	1.67	1.57	-
TOTAL COST OF COMPONENTS	9.70	14.51	9.80	4.29
Indirect Costs**	4.28	6.38	4.34	1.97
Working Capital (3 months)	0.98	1.10	1.05	1.72
Fuel Stockpile (75 days)	0.48	0.48	0.48	1.24
TOTAL CAPITAL COST	15.44	22.47	15.67	9.22

* 250 PSI saturated steam, Chicago region

** Engineering costs + construction management + contingency (each 10% of total cost of components) + interest during construction (10% annually)

TABLE 7-2

ANNUAL OPERATING COST COMPARISONS
PRELIMINARY COST DATA *
200,000 LB/HR PROCESS STEAM

ITEM	ANNUAL OPERATING COSTS (\$1980 MILLIONS)			
	PULVERIZED COAL BOILER WITH WET LIMESTONE SCRUBBER	ATMOSPHERIC FLUIDIZED BED (VENDOR)	ATMOSPHERIC FLUIDIZED BED (THEORY)	CONVENTIONAL OIL-FIRED BOILER WITH WET LIMESTONE SCRUBBER
Fuel	2.34	2.34	2.34	6.05
Operating and Maintenance	0.38	0.38	0.38	0.26
Electricity	0.11	0.14	0.14	0.04
Limestone	0.10	0.26	0.26	0.02
Other Consumables	0.29	0.27	0.27	0.27
Maintenance Materials	0.35	0.55	0.39	0.12
Waste Disposal	0.20	0.27	0.27	0.05
Insurance	<u>0.14</u>	<u>0.21</u>	<u>0.14</u>	<u>0.07</u>
TOTAL ANNUAL O&M COSTS	3.91	4.42	4.19	6.88

* Coal = \$31.00/ton = \$1.48/MMBTU. No. 6 oil = \$0.56/gal. = \$3.84/MMBTU
Limestone = \$10/ton. Waste disposal = \$7.50/ton
65 percent plant capacity factor, 250 PSIG saturated steam

TABLE 7-3

LEVELIZED LIFETIME ANNUAL COSTS
\$1980 PER 1000 POUNDS OF STEAM
200,000 LB/HR SATURATED STEAM

BOILER TYPE	CASE*	CAPITAL	FUEL	NON-FUEL O&M	TOTAL
Pulverized Coal Boiler with Wet Limestone Scrubber	I	3.44	5.19	2.84	11.47
	II	3.44	2.21	1.48	7.13
Atmospheric Fluidized Bed (Vendor)	I	5.00	5.18	3.75	13.93
	II	5.00	2.20	1.96	9.16
Atmospheric Fluidized Bed (Theory)	I	3.49	5.18	3.35	12.02
	II	3.49	2.20	1.75	7.44
Oil-Fired Boiler with Wet Limestone Scrubber	I	2.05	13.40	1.51	16.96
	II	2.05	5.70	0.79	8.54

*ASSUMPTIONS:

	CASE I	CASE II
Discount Rate for Capital Recovery Rate	0.15	0.15
Real Escalation Rate for Fuel Costs	0.10	0.00
Real Escalation Rate for Non-Fuel O&M Costs	0.08	0.00
30 Year Plant Life, 0.50 Tax Rate, 100% Equity Financing		

TABLE 7-4

PLANT CHARACTERISTICS
200,000 LB/HR PROCESS STEAM*

PLANT CHARACTERISTIC	BOILER TYPE		
	PULVERIZED COAL BOILER WITH BAGHOUSE AND WET LIMESTONE SCRUBBER	AFB BOILER WITH BAGHOUSE	OIL-FIRED BOILER WITH WET LIMESTONE SCRUBBER
FIRING RATE (MMBTU/HR)	275.6	274.7	278.8
BOILER SIZE (LBS OF STEAM/ HR)	237,000	234,000	237,000
BOILER OVER-ALL EFFICIENCY	0.86**	0.85**	0.85**
EXCESS AIR FRACTION FUEL FLOW	0.25** 13.3 T/HR	0.20** 13.2 T/HR	0.20** 1897 GAL/HR
LIMESTONE FLOW (T/HR)	1.8	4.6***	0.65
WASTE (T/HR)	4.7 (20% moisture)	6.3 (dry)	1.1 (20% moisture)
FLUE GAS ACFM @ 340°F	124,000	119,000	83,500

* 250 PSIG Saturated Steam. No condensate return.

Coal Characteristics: HHV = 10,500 BTU/LB, 10% BTU/LB, 10% ASH,
3.5% Sulfur, 12% Moisture

Oil Characteristics: HHV = 147,000 BTU/GAL, 0.12% ASH, 2% SULFUR, 0.75%
Moisture

** Model input

*** Ca/S ratio = 3.0

APPENDIX A

INDUSTRIAL STEAM PLANT EQUIPMENT ITEMS

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The figures in this Appendix show the major equipment items included in the COSTEAM capital cost categories. COSTEAM capital costs are grouped into nine major categories:

1. Major Boiler Equipment
2. Mechanical Equipment
3. Boiler Instruments
4. Fuel Handling and Storage
5. Flue Gas Cleanup and Handling
6. Dry Ash Handling
7. Wet Ash Handling
8. Spent Bed Materials Handling
9. Coal and Limestone Handling

Each of these categories includes a number of components.*

Equipment cost estimates were obtained from equipment suppliers. In addition, estimates were also obtained from contractors for the following six groups of costs:

1. Mechanical - Material costs include such items as flanges, pipe, hangers, ducting, seals, welding rods, bolts, nuts, small steel, paint, couplings, etc. necessary to assemble or install equipment required within each group.
2. Structural - Material costs include major support steel, gratings, welding rods, bolts, nuts, small steel, paint and other such items necessary to provide and erect the enclosed building.
3. Instrument - Material costs include tubing, fittings, headers, filters, supports, etc. necessary to install and tie together the purchased instruments.
4. Insulation - Material costs include refractory, insulation, lagging, heat tracing, weather proofing, etc. as required by design to be field installed.
5. Civil - Material costs include concrete, reinforcing bar, forms, underground pipe and fittings, etc. as required for

* To identify the component equipment, see Figure 2-3, Section 2.0 of this report.

foundations and flooring, drainage systems, and attendant site improvements.

6. Electrical - Material costs include miscellaneous small motors, motor starters, wire, conduit, supports, disconnects, fittings, lighting fixtures, transformers, etc., required to connect all major electrical components.

Labor costs are divided into only three groups due to variability of site specific requirements:

1. Unskilled labor which act as helpers and perform manual tasks.
2. Mechanical labor (i.e., pipe fitters, welders, millwrights, equipment operators), which perform the majority of erection and installation.
3. Electrical labor (electricians), which connect electrical components.

Rented Equipment lists the costs of employing construction equipment and includes cranes, trucks, welding machines, etc.

FIGURE A-1
COSTEAM PLANT COMPONENTS

FIGURE A-2
MAJOR BOILER EQUIPMENT—PULVERIZED COAL

FIGURE A-3
MAJOR BOILER EQUIPMENT—STOKER COAL

FIGURE A-4
AFB EQUIPMENT ITEMS

**FIGURE A-5
MAJOR BOILER EQUIPMENT—OIL**

A-10

FIGURE A-6
MECHANICAL EQUIPMENT

FIGURE A-7
BOILER INSTRUMENTS

FIGURE A-8
FUEL HANDLING AND STORAGE—COAL AND AFB

**FIGURE A-9
FUEL HANDLING FOR OIL-FIRED BOILER**

FIGURE A-10
FLUE GAS CLEANUP AND HANDLING
WET SCRUBBER

**FIGURE A-11
FLUE GAS CLEANUP AND HANDLING
DRY SCRUBBER**

**FIGURE A-12
FLUE GAS CLEANUP AND HANDLING AFB**

INCLUDES:

- ASH SILO
- EJECTOR
- SEPARATOR
- AIR WASHER
- VALVES
- TRANSPORT & DISPOSAL EQUIPMENT

A-17

FIGURE A-13
DRY ASH HANDLING EQUIPMENT

FIGURE A-14
WET ASH HANDLING EQUIPMENT—COAL

APPENDIX B

FINANCIAL CALCULATIONS IN SUBROUTINE FINANC

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● COSTEAM ASSUMPTIONS*

100% equity financing

Plant lifetime $L = 30$ years

Interest rate $t = 15\%$

Tax rate $t = 50\%$

Investment tax credit $= 0$

Escalation factor for capital costs $(ESC C_{tc}) = (1 + .1)^{tc-80}$

Escalation factor for fuel costs $(ESC F_{tc}) = (1 + .1)^{tc-80}$

Escalation factor for operating and maintenance costs $(ESC O/M_{tc}) = (1 + .08)^{tc-80}$

where tc = year of construction completion

80 = 1980, year in which COSTEAM costs are expressed.

● FIRST YEAR BEFORE TAX COSTS (FYBTC)

$$FYBTC_{tc} = (C_{80})(ESC C_{tc}) [CRF(i,L)] + (F_{80})(ESC F_{tc}) + (O/M_{80})(ESC O/M_{tc})$$

where C_{80} = capital costs in 1980 dollars

$ESC C_{tc}$ = escalation factor for capital costs to the year of construction completion

tc = year of construction completion

CRF = Capital recovery factor

i = interest rate

L = plant lifetime

F_{80} = fuel costs in 1980 dollars

*All assumed values listed here can be changed by the user, except for the 100% equity financing and the year (1980) in which COSTEAM costs are expressed.

ESC F_{tc} = escalation factor for fuel costs to the year of construction completion

O/M₈₀ = operating and maintenance costs in 1980 dollars

ESC O/M_{tc} = escalation factor for operating and maintenance costs to the year of construction completion.

● FIRST YEAR AFTER TAX COSTS (FYATC)

$$FYATC_{tc} = (C_{80}) (ESC C_{tc}) [FCR (i,L)] + (F_{80}) (ESC F_{tc}) + (O/M_{80}) (ESC O/M_{tc})$$

where FCR (i,L) = fixed charge rate

● LEVELIZED LIFETIME ANNUAL AFTER TAX COSTS (LLAATC)

$$LLAATC = (C_{80}) (ESC C_{tc}) FCR (i,L) + (F_{80}) (ESC F_{tc}) LEVEL (F) + (O/M_{80}) (ESC O/M_{tc}) LEVEL (O/M)$$

$$\text{where: } LEVEL (F \text{ or } O/M) = \frac{\left[\frac{1 + ESC (F \text{ or } O/M)}{1 + C} - 1 \right] \times CRF(i,L)}{\ln \left(1 + \frac{ESC C}{1+t} \right)}$$

● CAPITAL COST PER POUND OF STEAM PER HOUR

$$(C_{80}) (ESC_{tc}) (\text{Plant size})$$

● COST OF STEAM - FIRST YEAR BEFORE TAX

$$FYBTC_{tc} / (\text{Plant size}) (8760) (\text{capacity factor})$$

where 8760 is the number of hours in a year

● COST OF STEAM - FIRST YEAR AFTER TAX

$$FYATC_{tc} / (\text{Plant size}) (8760) (\text{capacity factor})$$

● COST OF STEAM - LEVELIZED LIFETIME COST

$$LLAATC / (\text{Plant size}) (8760) (\text{capacity factor})$$

● FIXED CHARGE RATE (FCR)

$$FCR (i,L) = \left(1 - \frac{1TC}{1+i} \right) \left(\frac{CRF(i,L)}{1-t} \right) - \frac{2t}{(1-t)L(L+1)i} \left(L - \frac{1}{CRF(i,L)} \right) CRF(i,L)$$

- CAPITAL COST RECOVERY FACTOR

$$CRF (i,L) = \frac{i}{1-(1+i)^{-L}}$$

APPENDIX C

AFB CAPITAL COST DATA AND DATA SOURCES

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The reference plant cost data used in COSTEAM were developed by Dr. Edwin F. Coxé of Applied Energy Sciences, Inc., in Atlanta, Georgia. Table C-1 gives the sources of the cost data for a 220,000 lb/hr atmospheric fluidized bed boiler plant. The equipment items correspond to a Babcock and Wilcox AFB design. From these sources, capital costs for reference plants were developed by Dr. Coxé for major boiler equipment, spent bed materials handling and coal and limestone feed equipment. The costs reflect prices in March 1980.

Capital costs for other equipment items in the reference AFB plants were derived from the Phase I cost data for conventional pulverized coal-fired plants. The pulverized coal system costs for limestone preparation and storage and dry ash handling were scaled up to reflect the larger quantities handled by the AFB system. In the AFB system, the dry ash handling system handles the spent bed materials leaving the screw cooler. Pulverized coal plant data were used for mechanical equipment, including the building, fuel storage and handling and boiler instruments.

Table C-2 contains the capital costs and scaling exponents for the costs of the equipment items in the reference AFB plants. Costs are presented for 100,000 and 200,000 and 400,000 lb/hr reference plants. The capital costs are on the upper line and the scaling exponent in the lower line in Table C-2. Costs are for plants built in the Atlanta, Georgia area. Costs for spent bed materials handling (SPENTBED) and coal and limestone feed (AFBMATS) are in 1980 dollars.

TABLE C-1
250,000 LB/HR FLUIDIZED BED BOILER PRICING CHART

ITEM	PRICE EACH	PRICE TOTAL	SOURCE	REMARKS
BOILER, (Tubes, Drums, Headers, etc.)	4,260,000	4,260,000	AES	20,200 ft ² heating surface, 1075 PSIG
SUPERHEATER	140,000	140,000	AES	11,500 ft ² heating surface, 925 PSIG, 900°F
ECONOMIZER	100,000	100,000	Zum Combustion Eng. (did not respond)	1100 PSIG design 300 M lb/hr Gas, 600°F in, 520°F out 230 M lb/hr H ₂ O, 360°F in, 390°F out 300 M lb/hr Gas, 520°F in, 360°F out 234 M lb/hr Air, 165°F in, 425°F out
TUBULAR AIR HEATER	240,000	240,000	AES Riley (did not respond)	
STEAM COIL AIR HEATER	5,000	5,000	TRANE	50 PSIG sat steam 15 M lb/hr Air, -20°F in, 200°F out
DIRECT FIRED AIR HEATER	50,000	50,000	Barn, Inc. Tulsa, OK	15 M lb/hr Air, 180°F in, 900°F out includes \$20,000 instrumentation
BOOSTER FANS	20,000	20,000	Jay	75 hp, 32" H ₂ O; 6500 ACFM
FEEDERS & CONVEYORS				
Coal (2)	7,271	34,542	Vibra Screw	38" gravimetric
Limestone	1,623	4,623	Vibra Screw	24" volumetric
Coal Conveyor	4,000	4,000	Jervis B. Webb	12" dia x 16' screw conveyor
Mixing Conveyor	7,000	7,000	Jervis B. Webb	20" dia x 24' ribbon conveyor
Elevator	4,000	4,000	Jervis B. Webb	20" dia x 24' screw conveyor as specified by Bw
Injection				
Reinjection	2015	12,090	Detroit Stoker	6" Rotary valve
Make-up	2382	14,292	Detroit Stoker	8" Rotary valve
Bypass	2015	12,090	Detroit Stoker	6" Rotary valve
FEED STORAGE TANK	18,000	18,000	Cobb Ind. Fabrications	10' diameter x 4'6" straight with 60° included angle hopper, Carbon Steel
LAYER LOADER	60,000	60,000	AES	feeder for 20 downspouts, bucket type distributor
DOWN SPOUTS	12,500	250,000	Cobb Industrial Fabrications and AES	20 SDA s.s., 1/4" thick 18' long tapering from 20" to 24" diameter
BED MAKE-UP BIN	10,000	20,000	Cobb Industrial Fabrications	3/8" Carbon Steel, 10' diameter and 5'9" straight with 60° included angle hopper.
METERING SCREW COOLER	80,000	160,000	Cobb Industrial Fabrications and AES	Carbon steel water jacketed shell and water-cooled screw, 8300 lb/hr bed material from 1550°F to 300°F
DUST COLLECTOR	40,000	40,000	Zum	1130, 300 ACF @ 520°F 7 = EOL, ΔP = 3" H ₂ O

TABLE C-2

AFB Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 100000. AFB (V) 1979

BOILER ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT S	CIVIL ***	ELECTR ***	UNSKILL + + + L A B O R + + +	MECHAN + + +	ELECTR + + +	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	2378000. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	62100. 0.50	0. 0.60	63900. 0.80	745100. 0.80	0. 0.80	61400. 0.60	62100. 0.0	802000. 0.0	3310500. 0.0	TURBS
3	5900. 0.0	1100. 0.60	0. 0.50	0. 0.80	300. 0.60	0. 0.50	840. 0.60	0. 0.80	1500. 0.80	360. 0.80	0. 0.0	2740. 0.0	1860. 0.0	10000. 0.0	OIL IGN.
5	24000. 0.0	3200. 0.60	0. 0.0	1800. 0.80	0. 0.0	900. 0.50	360. 0.60	0. 0.0	4500. 0.80	720. 0.80	600. 0.60	6360. 0.0	5220. 0.0	36680. 0.0	CL EQPS.
6	10800. 0.66	1100. 0.60	0. 0.50	0. 0.80	0. 0.60	1600. 0.50	1100. 0.60	1100. 0.80	2700. 0.80	1100. 0.80	600. 0.60	7800. 0.0	4600. 0.0	20100. 0.0	BOOSTER
7	86000. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	37300. 0.80	0. 0.80	0. 0.60	0. 0.0	37300. 0.0	123300. 0.0	SUPPLY
9	38600. 0.66	3500. 0.60	0. 0.0	1200. 0.80	2100. 0.60	1200. 0.50	4500. 0.60	900. 0.80	1600. 0.80	1400. 0.80	300. 0.60	12500. 0.0	3000. 0.0	55300. 0.0	F.O. PLAN
10	139900. 0.55	5600. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	5300. 0.80	10600. 0.80	0. 0.80	5700. 0.60	5600. 0.0	15000. 0.0	167100. 0.0	T AIR HT
11	55800. 0.60	2800. 0.60	0. 0.50	0. 0.80	4600. 0.60	0. 0.50	0. 0.60	1100. 0.80	5700. 0.80	0. 0.80	1100. 0.60	7400. 0.0	6400. 0.0	70700. 0.0	ECOM.
13	28700. 0.55	2200. 0.60	0. 0.50	0. 0.80	0. 0.60	4700. 0.50	1100. 0.50	2100. 0.80	4300. 0.80	1100. 0.80	600. 0.60	8000. 0.0	7500. 0.0	44800. 0.0	DEAFTER

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 100000.

AFB (T)

1979

BOILER ITEM	EQMT COST	MECH *****	STRUCT *****	INSTRUM *****	INSULAT *****	CIVIL *****	ELECTR *****	UNSKILL *****	MECHAN *****	ELECTP *****	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	666000. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	17400. 0.50	0. 0.60	17900. 0.80	208000. 0.80	0. 0.80	17200. 0.60	17400. 0.0	225900. 0.0	926500. 0.0	TUBES
3	5900. 0.0	1100. 0.60	0. 0.50	0. 0.80	300. 0.60	0. 0.50	840. 0.60	0. 0.80	1500. 0.80	350. 0.90	0. 0.0	2240. 0.0	1860. 0.0	10000. 0.0	OIL IGN.
5	24000. 0.0	3200. 0.60	0. 0.0	1800. 0.80	0. 0.0	900. 0.50	960. 0.60	0. 0.0	4500. 0.80	720. 0.80	600. 0.60	6860. 0.0	5220. 0.0	36580. 0.0	CL FDRS.
6	10800. 0.66	1100. 0.60	0. 0.50	0. 0.80	0. 0.60	1600. 0.50	1100. 0.60	1100. 0.80	2700. 0.80	1100. 0.80	600. 0.60	3870. 0.0	4900. 0.0	20100. 0.0	BOOSTER
7	43000. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	18700. 0.80	0. 0.90	0. 0.60	0. 0.0	18700. 0.0	61700. 0.0	SUPHTP
9	38600. 0.66	3500. 0.60	0. 0.0	1200. 0.80	2100. 0.60	1200. 0.50	4500. 0.60	900. 0.80	1600. 0.80	1400. 0.80	300. 0.60	12500. 0.0	3900. 0.0	55300. 0.0	F.O.FAN
10	139900. 0.55	5600. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	5300. 0.80	10600. 0.80	0. 0.80	5700. 0.60	5600. 0.0	15900. 0.0	167100. 0.0	T AIR HT
11	55800. 0.60	2800. 0.60	0. 0.50	0. 0.80	4600. 0.60	0. 0.50	0. 0.60	1100. 0.80	5300. 0.80	0. 0.80	1100. 0.60	7400. 0.0	6400. 0.0	70700. 0.0	ECON
13	28700. 0.55	2200. 0.60	0. 0.50	0. 0.80	0. 0.60	4700. 0.50	1100. 0.60	2100. 0.80	4300. 0.80	1100. 0.80	600. 0.60	8000. 0.0	7500. 0.0	44800. 0.0	DEFAHTR

C-6

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 100000. AFBCOAL 1979

MECHANIC ITEM	EQMT COST	MECH *****	STRUCT *****	INSTRUM *****	INSULAT *****	CIVIL *****	ELECTR *****	UNSKILL *****	MECHAN *****	ELECTR *****	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	25000. 0.47	3100. 0.60	0. 0.0	900. 0.80	0. 0.0	0. 0.0	0. 0.0	0. 0.80	3200. 0.60	0. 0.0	600. 0.60	4300. 0.0	3200. 0.0	32800. 0.0	DESUPHTR
2	76000. 0.50	10000. 0.60	5000. 0.50	6000. 0.80	10000. 0.60	2000. 0.50	3600. 0.60	1000. 0.80	22000. 0.80	1800. 0.80	4000. 0.60	36500. 0.0	24800. 0.0	135400. 0.0	SOFTNRS
3	47000. 0.60	8200. 0.60	0. 0.0	2400. 0.80	1900. 0.60	600. 0.50	3840. 0.60	300. 0.80	7000. 0.60	840. 0.80	300. 0.60	16940. 0.0	8140. 0.0	72380. 0.0	BLPUMP
4	14000. 0.78	3600. 0.60	3200. 0.50	1200. 0.80	1400. 0.60	0. 0.0	0. 0.0	1000. 0.0	2300. 0.60	0. 0.0	800. 0.60	9400. 0.0	3300. 0.0	27500. 0.0	FEEDHTR
5	80000. 0.60	90000. 0.60	11000. 0.50	0. 0.80	33000. 0.60	0. 0.50	0. 0.60	14000. 0.80	41000. 0.80	0. 0.80	7500. 0.60	134000. 0.0	55000. 0.0	276500. 0.0	VALVES
6	2900. 0.55	1700. 0.60	0. 0.50	0. 0.80	600. 0.60	0. 0.50	0. 0.60	0. 0.80	1600. 0.80	0. 0.80	0. 0.60	2300. 0.0	1600. 0.0	6900. 0.0	SCAHTP
7	0. 0.0	5000. 0.60	0. 0.50	0. 0.80	0. 0.60	15000. 0.50	18000. 0.60	5000. 0.80	5000. 0.80	10200. 0.80	2500. 0.60	38000. 0.0	20200. 0.0	60700. 0.0	HTTL
8	0. 0.0	3000. 0.60	45000. 0.50	0. 0.0	0. 0.60	8200. 0.50	13200. 0.60	6000. 0.80	14000. 0.80	7200. 0.80	9000. 0.60	69400. 0.0	29200. 0.0	107600. 0.0	BLDG SHP

REFERENCE SIZE= 100000. AFBCOAL 1979

INSTRUM ITEM	EQMT COST	MECH *****	STRUCT *****	INSTRUM *****	INSULAT *****	CIVIL *****	ELECTR *****	UNSKILL *****	MECHAN *****	ELECTR *****	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
2	10000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	10000. 0.0	FEED CON
4	10000. 0.90	2000. 0.60	0. 0.50	0. 0.80	0. 0.60	400. 0.50	600. 0.60	0. 0.80	2000. 0.80	240. 0.80	0. 0.60	3000. 0.0	2240. 0.0	15240. 0.0	COMP AIR

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

5	10000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	10000. 0.0	CON RM
6	10000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	10000. 0.0	FUEL C
7	40000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	40000. 0.0	CON CON
8	75000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	75000. 0.0	B. MGMT.
10	0. 0.0	15000. 0.60	0. 0.50	15000. 0.80	0. 0.60	0. 0.50	6000. 0.60	0. 0.80	75000. 0.80	36000. 0.80	0. 0.0	36000. 0.0	111000. 0.0	147000. 0.0	SYSTEM I

REFERENCE SIZE= 100000.

AFBCOAL

1979

C-8

FUELHAND ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT L S	CIVIL ***	ELECTR ***	UNSKILL + + +	MECHAN L A B O R	ELECTR + + +	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	7500. 0.20	5000. 0.60	5000. 0.50	0. 0.80	0. 0.60	5000. 0.50	6000. 0.60	6200. 0.80	21000. 0.80	5760. 0.80	6600. 0.60	21000. 0.0	32060. 0.0	68060. 0.0	UNLOADI
2	36000. 0.40	0. 0.60	0. 0.50	0. 0.80	0. 0.60	3200. 0.50	0. 0.60	2700. 0.80	0. 0.80	0. 0.80	0. 0.60	3200. 0.0	2700. 0.0	41900. 0.0	COAL ST
3	72500. 1.00	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	72500. 0.0	PAIL SOP
4	25000. 1.00	0. 0.60	0. 0.50	0. 0.80	0. 0.60	15000. 0.50	0. 0.60	12000. 0.80	13000. 0.80	0. 0.80	10000. 0.60	15000. 0.0	25000. 0.0	75000. 0.0	DRAIN SY
5	25000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	25000. 0.0	THAWER

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 100000. AFB COAL 1979

FLUEGAS ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM MATERIALS	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN LABOR	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	24300. 0.80	6200. 0.60	3400. 0.50	0. 0.80	3700. 0.60	0. 0.50	0. 0.60	0. 0.80	1100. 0.80	0. 0.80	300. 0.60	13300. 0.0	1100. 0.0	39000. 0.0	0.0
2	251700. 0.80	12500. 0.60	0. 0.50	0. 0.80	0. 0.60	16900. 0.50	3100. 0.60	5300. 0.80	4300. 0.80	2700. 0.80	12500. 0.60	32500. 0.0	12300. 0.0	309000. 0.0	BAGHOUSE
3	145000. 0.62	54000. 0.60	18000. 0.50	27000. 0.80	55000. 0.60	2000. 0.50	28900. 0.60	10000. 0.80	50000. 0.80	18000. 0.80	3000. 0.60	184800. 0.0	78000. 0.0	410800. 0.0	FLEET DEP
6	13200. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	13200. 0.0	LINE CRU
7	22200. 0.46	11400. 0.60	4500. 0.50	4800. 0.80	0. 0.60	3400. 0.50	4100. 0.60	6000. 0.80	12000. 0.80	3440. 0.80	2300. 0.60	28200. 0.0	2140. 0.0	74140. 0.0	LINE SIL
9	35000. 0.66	5500. 0.60	0. 0.50	1500. 0.80	3000. 0.60	1600. 0.50	7200. 0.60	1000. 0.80	7500. 0.80	4800. 0.80	1000. 0.60	18800. 0.0	13300. 0.0	68100. 0.0	1.0. FAW
10	20000. 0.60	2500. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	500. 0.80	2500. 0.80	0. 0.80	800. 0.60	7500. 0.0	3000. 0.0	26300. 0.0	STACK

REFERENCE SIZE= 100000. AFB COAL 1979

DRYASH ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM MATERIALS	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN LABOR	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	62500. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	62500. 0.0	ASH SILE
2	19300. 0.54	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	19300. 0.0	EJECTOR

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

3	61400. 0.46	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	61400. 0.0	SEPARATO
4	21600. 0.70	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	21600. 0.0	AIR WASH
5	21700. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	21700. 0.0	VALVS/P
6	29000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	5500. 0.50	0. 0.60	1100. 0.80	0. 0.80	0. 0.80	0. 0.60	5500. 0.0	1100. 0.0	35600. 0.0	ASH TRAN
7	0. 0.0	13800. 0.60	9100. 0.50	0. 0.80	0. 0.60	6400. 0.50	7500. 0.60	23200. 0.80	65000. 0.80	6100. 0.80	15600. 0.60	36300. 0.0	94300. 0.0	146700. 0.0	ASH EQUI

REFERENCE SIZE= 100000. AFB (V) 1980

C-10

SPENTBEO

ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT ***	CIVIL ***	ELECTP ***	UNSKILL + + + L A B O R + + +	MECHAN ***	ELECTP ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	95100. 0.66	1600. 0.60	0. 0.50	0. 0.80	1200. 0.60	700. 0.50	900. 0.60	1100. 0.80	16000. 0.80	500. 0.80	1900. 0.60	4400. 0.0	17600. 0.0	119600. 0.0	COOLER
2	11900. 0.66	9300. 0.60	3400. 0.50	1600. 0.80	6200. 0.60	0. 0.50	0. 0.60	0. 0.80	4300. 0.80	0. 0.80	600. 0.60	27500. 0.0	4300. 0.0	37300. 0.0	PUMP
3	7100. 0.66	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	600. 0.60	0. 0.80	500. 0.80	300. 0.80	0. 0.60	600. 0.0	800. 0.0	8500. 0.0	PUMP
4	8500. 0.66	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	500. 0.60	0. 0.80	500. 0.80	300. 0.80	0. 0.60	600. 0.0	800. 0.0	9900. 0.0	PUMP
5	7100. 0.66	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	600. 0.60	0. 0.80	500. 0.80	300. 0.80	0. 0.60	600. 0.0	800. 0.0	8500. 0.0	PUMP

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

C-11

REFERENCE SIZE= 100000. AFB (T) 1980															
SPENTBEO ITEM	EQMT COST	MECH * * * *	STRUCT * * * *	INSTRUM M A T E R I A L S	INSULAT L S	CIVIL * * * *	ELECTR * * * *	UNSKILL * * * *	MECHAN L A B O R	ELECTR * * *	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	9510. 0.66	160. 0.60	0. 0.50	0. 0.80	120. 0.60	70. 0.50	70. 0.60	110. 0.80	1600. 0.80	50. 0.80	190. 0.60	440. 0.0	1760. 0.0	11900. 0.0	COOLER
2	11900. 0.66	9300. 0.60	3400. 0.50	1500. 0.80	6200. 0.60	0. 0.50	0. 0.60	0. 0.80	4300. 0.80	0. 0.80	600. 0.60	20500. 0.0	4300. 0.0	37300. 0.0	RIN
3	7100. 0.66	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	600. 0.60	0. 0.80	500. 0.80	300. 0.80	0. 0.60	600. 0.0	800. 0.0	8500. 0.0	R FOR
4	8500. 0.66	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	600. 0.60	0. 0.80	500. 0.80	300. 0.80	0. 0.60	600. 0.0	800. 0.0	9900. 0.0	M FOR
5	7100. 0.66	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	600. 0.60	0. 0.80	500. 0.80	300. 0.30	0. 0.60	600. 0.0	800. 0.0	8500. 0.0	RY FOR
REFERENCE SIZE= 100000. AFBONAL 1980															
AFBMATS ITEM	EQMT COST	MECH * * * *	STRUCT * * * *	INSTRUM M A T E R I A L S	INSULAT L S	CIVIL * * * *	ELECTR * * * *	UNSKILL * * * *	MECHAN L A B O R	ELECTR * * *	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	186900. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	3100. 0.60	1600. 0.80	16000. 0.80	2700. 0.80	3100. 0.60	3100. 0.0	20300. 0.0	217400. 0.0	COAL FOR
2	2500. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	100. 0.60	0. 0.80	1100. 0.80	100. 0.80	100. 0.60	100. 0.0	1200. 0.0	3900. 0.0	
3	2900. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	100. 0.60	0. 0.80	1100. 0.80	100. 0.80	100. 0.60	100. 0.0	1200. 0.0	4300. 0.0	L FOR

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

4	4400. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	200. 0.60	0. 0.80	2100. 0.80	100. 0.80	100. 0.60	200. 0.0	2200. 0.0	6000. 0.0	M CONVR
5	4400. 0.60	0. 0.60	2800. 0.50	0. 0.80	0. 0.60	0. 0.50	200. 0.60	0. 0.80	2100. 0.80	100. 0.80	100. 0.60	3000. 0.0	2200. 0.0	9700. 0.0	ELEV
6	11200. 0.60	0. 0.60	2700. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	9600. 0.80	0. 0.80	3100. 0.60	2700. 0.0	9600. 0.0	26600. 0.0	F DUMKR
7	49800. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	1200. 0.60	2100. 0.80	5300. 0.80	1100. 0.90	1200. 0.60	1200. 0.0	8500. 0.0	60700. 0.0	L DR
8	155800. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	10600. 0.80	0. 0.80	3700. 0.60	0. 0.0	10500. 0.0	170100. 0.0	OSPOUT
9	37400. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	1900. 0.60	0. 0.80	10600. 0.80	1600. 0.80	1200. 0.60	1900. 0.0	12200. 0.0	52700. 0.0	IN FDRS
10	89700. 0.60	6200. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	26600. 0.80	0. 0.80	2500. 0.60	6200. 0.0	26600. 0.0	125000. 0.0	PIPING

REFERENCE SIZE= 200000.

AFB (V)

1979

BOILER ITEM	EQMT COST	MECH *****	STRUCT *****	INSTRUM *****	INSULAT *****	CIVIL *****	ELECTR *****	UNSKILL *****	MECHAN *****	ELECTR *****	RENTAL *****	MATERIAL *****	LABOR *****	TOTAL *****	TOTAL *****	TOTAL *****	TOTAL *****
1	3604400. 0.60	0. 0.60	0. 0.50	0. 0.30	0. 0.60	87800. 0.50	0. 0.60	111200. 0.80	1297200. 0.80	0. 0.80	93100. 0.60	87800. 0.0	1408400. 0.0	5193700. 0.0			TUBES
3	7500. 0.0	2000. 0.60	0. 0.50	0. 0.80	500. 0.60	0. 0.50	840. 0.60	0. 0.80	2500. 0.80	360. 0.80	0. 0.0	3340. 0.0	2860. 0.0	13700. 0.0			OIL IG
5	36000. 0.0	6000. 0.60	0. 0.0	3000. 0.80	0. 0.0	1500. 0.50	1800. 0.60	0. 0.0	8000. 0.80	1440. 0.80	1900. 0.60	12300. 0.0	9440. 0.0	59540. 0.0			CL. FDRS
6	17100. 0.66	1700. 0.60	0. 0.50	0. 0.80	0. 0.60	2200. 0.50	1700. 0.60	1900. 0.80	4600. 0.80	1900. 0.80	900. 0.60	5600. 0.0	8400. 0.0	32000. 0.0			BOOSTER

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

7	130400. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	64900. 0.80	0. 0.80	0. 0.60	0. 0.0	64900. 0.0	195300. 0.0	SUPHTR
9	68000. 0.66	7100. 0.60	0. 0.0	2200. 0.80	3600. 0.60	2900. 0.50	6900. 0.60	1600. 0.80	4100. 0.80	2800. 0.80	700. 0.60	22700. 0.0	8500. 0.0	100100. 0.0	F.O.FAN/
10	204900. 0.55	8500. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	9300. 0.80	18500. 0.80	0. 0.80	8600. 0.60	8500. 0.0	27870. 0.0	249800. 0.0	T AIR HT
11	84600. 0.60	4200. 0.60	0. 0.50	0. 0.80	7000. 0.60	0. 0.50	0. 0.60	1900. 0.80	9300. 0.80	0. 0.80	1700. 0.60	11700. 0.0	11200. 0.0	103700. 0.0	ECON
13	42000. 0.55	3400. 0.60	0. 0.50	0. 0.80	0. 0.60	6600. 0.50	1700. 0.60	3700. 0.80	7400. 0.80	1900. 0.80	900. 0.60	11700. 0.0	13000. 0.0	67600. 0.0	DEAMTR

REFERENCE SIZE= 200000. AFB (Y) 1979

C-13

BOILER ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL + + +	MECHAN L A B O R	ELECTR + + +	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	1020000. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	24600. 0.50	0. 0.60	31100. 0.80	393000. 0.80	0. 0.80	26200. 0.60	24500. 0.0	424100. 0.0	1494900. 0.0	TURES
3	7500. 0.0	2000. 0.60	0. 0.50	0. 0.80	500. 0.60	0. 0.50	840. 0.60	0. 0.80	2500. 0.80	360. 0.80	0. 0.0	3340. 0.0	2860. 0.0	13700. 0.0	WIL IG
5	36000. 0.0	6000. 0.60	0. 0.0	3000. 0.80	0. 0.0	1500. 0.50	1800. 0.60	0. 0.0	8000. 0.80	1440. 0.80	1800. 0.60	12300. 0.0	9440. 0.0	59540. 0.0	CL.FDPS
6	17100. 0.66	1700. 0.60	0. 0.50	0. 0.80	0. 0.60	2200. 0.50	1700. 0.60	1900. 0.80	4600. 0.80	1900. 0.80	900. 0.60	5600. 0.0	8400. 0.0	37000. 0.0	ROOSTEP
7	65200. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	32500. 0.80	0. 0.80	0. 0.60	0. 0.0	32500. 0.0	97700. 0.0	SUPHTR

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

9	68000. 0.66	7100. 0.60	0. 0.0	2200. 0.80	3600. 0.60	2900. 0.50	6900. 0.60	1600. 0.80	4100. 0.80	2800. 0.80	900. 0.60	22700. 0.0	8500. 0.0	100100. 0.0	F.O.FAN/
10	204900. 0.55	8500. 0.60	0. 0.50	0. 0.90	0. 0.60	0. 0.50	0. 0.60	9300. 0.80	18500. 0.80	0. 0.80	8500. 0.60	8500. 0.0	27800. 0.0	249800. 0.0	T AIR HT
11	84600. 0.60	4200. 0.60	0. 0.50	0. 0.80	7000. 0.60	0. 0.50	0. 0.60	1900. 0.80	9300. 0.80	0. 0.80	1700. 0.60	11200. 0.0	11200. 0.0	108700. 0.0	FCOV
13	42000. 0.55	3400. 0.60	0. 0.50	0. 0.80	0. 0.60	6600. 0.50	1700. 0.60	3700. 0.80	7400. 0.80	1900. 0.90	900. 0.60	11700. 0.0	13000. 0.0	67800. 0.0	DEAHTR
REFERENCE SIZE= 200000. AFB/CAL 1979															

C-14

MECHANIC ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT L S	CIVIL ***	ELECTR ***	UNSKILL + + +	MECHAN L A B O R	ELECTR + + +	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	40000. 0.47	4800. 0.60	0. 0.0	1600. 0.80	0. 0.0	0. 0.0	0. 0.0	0. 0.80	4700. 0.60	0. 0.0	1500. 0.60	6400. 0.0	4700. 0.0	52600. 0.0	DESUPHTR
2	100000. 0.50	17000. 0.60	8000. 0.50	10000. 0.30	17000. 0.60	3500. 0.50	5880. 0.60	1600. 0.80	38000. 0.80	3600. 0.80	6500. 0.60	61380. 0.0	43200. 0.0	21090. 0.0	SOFTNEPS
3	75000. 0.60	15000. 0.60	0. 0.0	4000. 0.80	3500. 0.60	1800. 0.50	6000. 0.60	1030. 0.80	25000. 0.60	2520. 0.80	2000. 0.60	30300. 0.0	28520. 0.0	135820. 0.0	BLR.PUMP
4	25000. 0.78	6000. 0.60	5000. 0.50	1800. 0.90	2200. 0.60	0. 0.0	0. 0.0	1890. 0.0	4000. 0.60	0. 0.0	1400. 0.60	15000. 0.0	5800. 0.0	47200. 0.0	FO.W.HTR
5	125000. 0.60	150000. 0.60	25000. 0.50	0. 0.80	50000. 0.60	0. 0.50	0. 0.60	25000. 0.80	75000. 0.80	0. 0.80	20000. 0.60	225000. 0.0	100000. 0.0	470000. 0.0	VALVES
6	4300. 0.55	2500. 0.60	0. 0.50	0. 0.80	900. 0.60	0. 0.50	0. 0.60	0. 0.80	2800. 0.80	0. 0.80	0. 0.60	3400. 0.0	2800. 0.0	10500. 0.0	SCAHTR
7	0. 0.0	9000. 0.60	0. 0.50	0. 0.80	0. 0.60	26000. 0.50	31200. 0.60	9000. 0.80	9000. 0.80	18000. 0.80	4300. 0.60	66200. 0.0	36000. 0.0	106500. 0.0	UTILITIF
8	0. 0.0	5000. 0.60	80000. 0.50	0. 0.0	0. 0.60	15000. 0.50	24000. 0.60	15000. 0.80	25000. 0.80	13200. 0.80	17000. 0.60	124000. 0.0	53200. 0.0	194200. 0.0	BLDG.SHP

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 200000.

AFBCOAL

1979

INSTRUM ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN L A B O R	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
2	15000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	15000. 0.0	FFED CON
4	17000. 0.90	3500. 0.60	0. 0.50	0. 0.80	0. 0.60	700. 0.50	1090. 0.60	0. 0.80	34000. 0.80	480. 0.30	0. 0.60	5280. 0.0	34480. 0.0	56760. 0.0	COMP AIR
5	10000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	10000. 0.0	CON RM
6	10000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	10000. 0.0	FUEL C
7	40000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	40000. 0.0	CON CON
8	75000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	75000. 0.0	B.MGMT.
10	0. 0.0	15000. 0.60	0. 0.50	15000. 0.80	0. 0.60	0. 0.50	6000. 0.60	0. 0.80	75000. 0.80	36000. 0.80	0. 0.0	36000. 0.0	111000. 0.0	147000. 0.0	INST. IN

REFERENCE SIZE= 200000.

AFBCOAL

1979

FUELHAND ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN L A B O R	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	75000. 0.25	5000. 0.60	9000. 0.50	0. 0.80	0. 0.60	9500. 0.50	10440. 0.60	7800. 0.80	34000. 0.80	9960. 0.80	9200. 0.60	33340. 0.0	51760. 0.0	169300. 0.0	UNLOADIN
2	56000. 0.46	0. 0.0	0. 0.0	0. 0.0	0. 0.0	5000. 0.50	0. 0.0	4000. 0.80	0. 0.0	0. 0.0	0. 0.60	5000. 0.0	4000. 0.0	65000. 0.0	COAL SIL

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

3	150000. 1.00	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 1.0	0. 0.0	0. 0.0	150000. 0.0	RAIL SPIR
4	50000. 1.00	0. 0.60	0. 0.50	0. 0.80	0. 0.60	27000. 0.50	0. 0.50	21000. 0.80	23000. 0.80	0. 0.80	17500. 0.60	27000. 0.0	44000. 0.0	138500. 0.0	0.0	OPAIN SV
5	50000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	0. 0.0	50000. 0.0	THAWER

REFERENCE SIZE= 200000.

AFRCOAL

1979

FLUEGAS

ITEM	EQMT COST	MECH ***	STRUCT ***	INSTUM M A T	INSULAT E R I A L S	CIVIL ***	ELECTR ***	UNSKILL + + +	MECHAN L A B O R	ELECTR + + +	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	42300. 0.80	9400. 0.60	4800. 0.50	0. 0.80	5700. 0.60	0. 0.50	0. 0.80	0. 0.80	1900. 0.80	0. 0.80	500. 0.60	19900. 0.0	1900. 0.0	64600. 0.0	9 COL
2	438300. 0.80	18900. 0.60	0. 0.50	0. 0.80	0. 0.60	23800. 0.50	4700. 0.60	9300. 0.80	7400. 0.80	4600. 0.80	18900. 0.60	47400. 0.0	21300. 0.0	525900. 0.0	WAGHOUSE
3	265000. 0.62	100000. 0.60	40000. 0.50	50000. 0.80	107000. 0.60	4000. 0.50	48000. 0.60	27000. 0.80	85000. 0.80	33600. 0.80	7000. 0.60	349300. 0.0	145600. 0.0	766600. 0.0	ELECT. ST
6	20000. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	20000. 0.0	LINE COU
7	55400. 0.46	26300. 0.60	10100. 0.50	4800. 0.80	0. 0.60	5600. 0.50	6200. 0.60	9000. 0.80	20300. 0.80	4300. 0.80	4000. 0.60	53000. 0.0	33600. 0.0	146000. 0.0	LINE ST
9	60000. 0.66	10000. 0.60	0. 0.50	1800. 0.80	4500. 0.60	3000. 0.50	13200. 0.60	1500. 0.80	12000. 0.80	8400. 0.80	1500. 0.60	32500. 0.0	21900. 0.0	115900. 0.0	1.0. PAN/
10	35000. 0.60	4000. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	800. 0.80	4000. 0.80	0. 0.80	1500. 0.60	4000. 0.0	4800. 0.0	45300. 0.0	STACK

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 200000. AFB/CAL 1979

OSVASH ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM MATERIALS	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL LABOR	MECHAN ***	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	124000. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	124000. 0.0	ASH SILE
2	37300. 0.54	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	37300. 0.0	EJECTOR
3	121000. 0.46	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	121000. 0.0	SEPARATE
4	42500. 0.70	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	42500. 0.0	AIRWASH
5	43400. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	43400. 0.0	VALVES/P
6	60000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	8600. 0.50	0. 0.60	2100. 0.80	0. 0.80	0. 0.80	0. 0.60	3600. 0.0	2100. 0.0	70700. 0.0	ASHES/SP
7	0. 0.0	26800. 0.60	17800. 0.50	0. 0.80	0. 0.60	12700. 0.50	15000. 0.60	45600. 0.80	130000. 0.80	12300. 0.80	31100. 0.60	22300. 0.0	187000. 0.0	291300. 0.0	OSVASHED

REFERENCE SIZE= 200000. AFB (V) 1980

SPENT3ED ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM MATERIALS	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL LABOR	MECHAN ***	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	150200. 0.66	2400. 0.60	0. 0.50	0. 0.80	1900. 0.60	1000. 0.50	1400. 0.60	1900. 0.80	27800. 0.80	900. 0.80	2800. 0.60	4700. 0.0	30600. 0.0	190300. 0.0	COOLERS
2	18600. 0.66	14200. 0.60	4800. 0.50	2800. 0.80	9400. 0.60	0. 0.50	0. 0.60	0. 0.80	7400. 0.80	0. 0.80	900. 0.60	31200. 0.0	7400. 0.0	55300. 0.0	PIPE

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

3	11300. 0.66	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	900. 0.60	0. 0.80	900. 0.80	500. 0.80	0. 0.60	900. 0.0	1400. 0.0	13600. 0.0	2.500
4	13400. 0.66	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	900. 0.60	0. 0.80	900. 0.80	500. 0.80	0. 0.60	900. 0.0	1400. 0.0	15700. 0.0	4.500
5	11300. 0.66	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	900. 0.60	0. 0.80	900. 0.80	500. 0.60	0. 0.60	900. 0.0	1400. 0.0	13600. 0.0	BY 500

REFERENCE SIZE= 200000. AFB (T) 1980

C-18

ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN L A B O R	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	15020. 0.66	240. 0.60	0. 0.50	0. 0.80	190. 0.60	100. 0.50	140. 0.60	190. 0.80	2780. 0.80	90. 0.80	280. 0.60	570. 0.0	3060. 0.0	19030. 0.0	COPIER
2	18800. 0.66	14200. 0.60	4800. 0.50	2800. 0.80	9400. 0.60	0. 0.50	0. 0.60	0. 0.80	7400. 0.80	0. 0.80	900. 0.60	31280. 0.0	7400. 0.0	59300. 0.0	FIN
3	11300. 0.66	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	900. 0.60	0. 0.80	900. 0.80	500. 0.80	0. 0.60	900. 0.0	1400. 0.0	13600. 0.0	2.500
4	13400. 0.66	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	900. 0.60	0. 0.80	900. 0.80	500. 0.80	0. 0.60	900. 0.0	1400. 0.0	15700. 0.0	4.500
5	11300. 0.66	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	900. 0.60	0. 0.80	900. 0.80	500. 0.80	0. 0.60	900. 0.0	1400. 0.0	13600. 0.0	BY 500

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 200000.

AFBCOAL

1980

AFBMATS

ITEM	EQMT COST	MECH *****	STRUCT *****	INSTRUM M A T E R I A L S	INSULAT *****	CIVIL *****	ELECTR *****	UNSKILL + + +	MECHAN L A B O R	ELECTR + + +	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	283300. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	4700. 0.60	2800. 0.80	27800. 0.80	4600. 0.80	4700. 0.60	4700. 0.0	35200. 0.0	327900. 0.0	COAL FOR
2	3800. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	200. 0.60	0. 0.80	1900. 0.80	200. 0.80	200. 0.60	200. 0.0	2100. 0.0	6300. 0.0	
3	4300. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	200. 0.60	0. 0.80	1900. 0.80	200. 0.80	200. 0.60	200. 0.0	2100. 0.0	6800. 0.0	L FOR
4	6600. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	300. 0.60	0. 0.80	3700. 0.80	200. 0.80	200. 0.60	300. 0.0	3900. 0.0	11000. 0.0	M CONVEY
5	6600. 0.60	0. 0.60	4000. 0.50	0. 0.80	0. 0.60	0. 0.50	300. 0.60	0. 0.80	3700. 0.80	200. 0.80	200. 0.60	4300. 0.0	3900. 0.0	15000. 0.0	ELEV
6	17000. 0.60	0. 0.60	3800. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	16700. 0.80	0. 0.80	4700. 0.60	2800. 0.0	16700. 0.0	42200. 0.0	F BRIDGE
7	75600. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	1900. 0.60	3700. 0.80	9300. 0.80	1900. 0.80	1900. 0.60	1900. 0.0	14900. 0.0	94200. 0.0	L FOR
8	236100. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	18500. 0.80	0. 0.80	5700. 0.60	0. 0.0	18500. 0.0	260300. 0.0	OSPORT
9	56700. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	2800. 0.60	0. 0.80	18500. 0.80	2800. 0.80	1900. 0.60	2800. 0.0	21300. 0.0	82700. 0.0	IN FORS
10	136000. 0.60	9400. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	46300. 0.80	0. 0.80	3800. 0.60	9400. 0.0	46300. 0.0	195600. 0.0	SHEDING

C-19

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 400000.

AFB (V)

1979

BOILER ITEM	EQMT COST	MECH	STRUCT	INSTRUM	INSULAT	CIVIL	ELECTR	UNSKILL	MECHAN	ELECTP	RENTAL	MATERIAL	LABOR	TOTAL	
		***	***	***	***	***	***	***	***	***	***	***	***	***	
1	5463300. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	124200. 0.50	0. 0.60	193600. 0.80	2258600. 0.80	0. 0.80	141200. 0.60	124200. 0.0	2452200. 0.0	2180000. 0.0	TUBES
3	11000. 0.0	3500. 0.60	0. 0.50	0. 0.80	900. 0.60	0. 0.50	1440. 0.60	0. 0.80	4200. 0.80	600. 0.80	0. 0.0	5340. 0.0	4800. 0.0	21640. 0.0	DRILLING
5	60000. 0.0	9800. 0.60	0. 0.0	5000. 0.80	0. 0.0	2300. 0.50	2760. 0.60	0. 0.0	13000. 0.80	2280. 0.80	3000. 0.60	19360. 0.0	15280. 0.0	98140. 0.0	CL 5025
6	27000. 0.66	2600. 0.60	0. 0.50	0. 0.80	0. 0.60	3100. 0.50	2600. 0.60	3200. 0.80	8100. 0.80	3200. 0.80	1300. 0.60	8700. 0.0	14500. 0.0	51100. 0.0	BOOSTER
7	197600. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	112900. 0.80	0. 0.80	0. 0.60	0. 0.0	112900. 0.0	310500. 0.0	SUPPLY
9	113500. 0.66	10800. 0.60	0. 0.0	3500. 0.80	5600. 0.60	5900. 0.50	11500. 0.60	2800. 0.80	7100. 0.80	5100. 0.80	2300. 0.60	36400. 0.0	15000. 0.0	167200. 0.0	F.O.F.W.
10	333400. 0.55	14300. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	1610. 0.80	3230. 0.80	0. 0.80	1400. 0.60	14300. 0.0	4840. 0.0	353940. 0.0	T 110 5A
11	128200. 0.60	6400. 0.60	0. 0.50	0. 0.80	10500. 0.60	0. 0.50	0. 0.60	3200. 0.80	16100. 0.80	0. 0.80	2600. 0.60	16900. 0.0	19300. 0.0	167000. 0.0	EQMT
13	62000. 0.55	5100. 0.60	0. 0.50	0. 0.80	0. 0.60	9300. 0.50	2600. 0.60	6500. 0.80	12900. 0.80	3200. 0.80	1300. 0.60	17000. 0.0	22600. 0.0	102900. 0.0	DEATH

C-20

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 400000.

AFB (T)

1979

BOILER ITEM	EQMT COST	MECH *****	STRUCT *****	INSTRUM *****	INSULAT *****	CIVIL *****	ELECTR *****	UNSKILL *****	MECHAN *****	ELECTR *****	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	1540000. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	34800. 0.50	0. 0.60	54400. 0.80	634000. 0.80	0. 0.80	39600. 0.60	34800. 0.0	648400. 0.0	2302000. 0.0	TURFS
3	11000. 0.0	3500. 0.60	0. 0.50	0. 0.80	900. 0.60	0. 0.50	1440. 0.60	0. 0.80	4200. 0.80	600. 0.80	0. 0.0	5840. 0.0	4800. 0.0	21640. 0.0	OIL IGM.
5	60000. 0.0	9800. 0.60	0. 0.0	5000. 0.80	0. 0.0	2300. 0.50	2760. 0.60	0. 0.0	13000. 0.80	2280. 0.80	3000. 0.60	19860. 0.0	15280. 0.0	98140. 0.0	CL FDRS
6	27000. 0.66	2600. 0.60	0. 0.50	0. 0.80	0. 0.60	3100. 0.50	2600. 0.60	3200. 0.80	8100. 0.80	3200. 0.80	1300. 0.60	8300. 0.0	14500. 0.0	51100. 0.0	ROOSTER
7	98800. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	56500. 0.80	0. 0.80	0. 0.60	0. 0.0	56500. 0.0	155300. 0.0	SUPHTR
9	113500. 0.66	10800. 0.60	0. 0.0	3500. 0.80	5600. 0.60	5000. 0.50	11500. 0.60	2800. 0.80	7100. 0.80	5100. 0.80	2300. 0.60	35400. 0.0	15000. 0.0	167200. 0.0	F.O.FAM
10	333400. 0.55	14300. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	1610. 0.80	3230. 0.80	0. 0.80	1400. 0.60	14300. 0.0	4840. 0.0	353940. 0.0	T AIR FA
11	128200. 0.60	6400. 0.60	0. 0.50	0. 0.80	10500. 0.60	0. 0.50	0. 0.60	3200. 0.80	16100. 0.80	0. 0.80	2600. 0.60	14900. 0.0	19300. 0.0	157000. 0.0	ECON
13	62000. 0.55	5100. 0.60	0. 0.50	0. 0.80	0. 0.60	9300. 0.50	2600. 0.60	5500. 0.80	12900. 0.80	3200. 0.80	1300. 0.60	17000. 0.0	22600. 0.0	102000. 0.0	DEAHTP

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 400000.

AFBCOAL

1979

MECHANIC

ITEM	EQMT COST	MECH *****	STRUCT *****	INSTRUM *****	INSULAT *****	CIVIL *****	ELECTR *****	UNSKILL *****	MECHAN *****	ELECTR *****	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	65000. 0.47	7600. 0.60	0. 0.0	3000. 0.80	0. 0.0	0. 0.0	0. 0.0	0. 0.80	8600. 0.60	0. 0.0	2500. 0.60	80500. 0.0	8600. 0.0	86700. 0.0	DESUPER
2	175000. 0.50	26000. 0.60	14000. 0.50	15000. 0.80	25000. 0.60	6000. 0.50	9600. 0.60	24000. 0.80	55000. 0.80	7200. 0.80	10000. 0.60	95500. 0.0	96200. 0.0	376800. 0.0	SOFTENERS
3	135000. 0.60	29000. 0.60	0. 0.0	7000. 0.80	6200. 0.60	3400. 0.50	11400. 0.60	1800. 0.80	45000. 0.60	4800. 0.80	4000. 0.60	57000. 0.0	51600. 0.0	247600. 0.0	RLR PUMP
4	40000. 0.78	10000. 0.60	8000. 0.50	3200. 0.80	3500. 0.60	0. 0.0	0. 0.0	3400. 0.0	6500. 0.60	0. 0.0	2300. 0.60	24700. 0.0	9000. 0.0	76000. 0.0	FD W. HT
5	215000. 0.60	260000. 0.60	45000. 0.50	0. 0.80	90000. 0.60	0. 0.50	0. 0.60	4500. 0.80	130000. 0.80	0. 0.80	40000. 0.60	795000. 0.0	134500. 0.0	784500. 0.0	VALVES
6	6200. 0.55	3900. 0.60	0. 0.50	0. 0.80	1300. 0.60	0. 0.50	0. 0.60	0. 0.80	4800. 0.80	0. 0.80	0. 0.60	5200. 0.0	4800. 0.0	16200. 0.0	SCAHTP
7	0. 0.0	15000. 0.60	0. 0.50	0. 0.80	0. 0.60	50000. 0.50	60000. 0.60	17000. 0.80	17000. 0.80	33600. 0.80	7000. 0.60	125000. 0.0	67600. 0.0	199600. 0.0	UTILS.
8	0. 0.0	8000. 0.60	140000. 0.50	0. 0.0	0. 0.60	26000. 0.50	44400. 0.60	28000. 0.80	45000. 0.80	24000. 0.80	30000. 0.60	218400. 0.0	97000. 0.0	345400. 0.0	BLOGS/PL

REFERENCE SIZE= 400000.

AFBCOAL

1979

INSTRUM

ITEM	EQMT COST	MECH *****	STRUCT *****	INSTRUM *****	INSULAT *****	CIVIL *****	ELECTR *****	UNSKILL *****	MECHAN *****	ELECTR *****	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
2	15000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	15000. 0.0	FEED CON

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

5	10000. 0.0	0. 0.60	0. 0.50	0. 0.30	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	10000. 0.0	CON RM
6	10000. 0.0	0. 0.60	0. 0.50	0. 0.30	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	10000. 0.0	FUEL C
7	40000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	40000. 0.0	CON CON
8	75000. 0.0	0. 0.60	0. 0.50	0. 0.30	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	75000. 0.0	B.MGMT.
10	0. 0.0	20000. 0.60	0. 0.50	20000. 0.30	0. 0.60	0. 0.50	12000. 0.60	0. 0.80	100000. 0.80	48000. 0.80	0. 0.0	52000. 0.0	148000. 0.0	200000. 0.0	INSTRM I

C-23

REFERENCE SIZE= 400000.

AFBCOAL

1979

FUELHAND ITEM	EOMT COST	MECH ***	STRUCT ***	INSTRUM MATERIALS	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN LABOR	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	550000. 0.25	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	550000. 0.0	UNLOADIN
2	78000. 0.46	0. 0.0	0. 0.0	0. 0.0	0. 0.0	8000. 0.50	0. 0.0	6500. 0.80	0. 0.0	0. 0.0	0. 0.60	8000. 0.0	6500. 0.0	92500. 0.0	COAL SH
3	300000. 1.00	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	300000. 0.0	RATE SH
4	100000. 1.00	0. 0.60	0. 0.50	0. 0.80	0. 0.60	50000. 0.50	0. 0.60	40000. 0.80	45000. 0.80	0. 0.80	25000. 0.60	50000. 0.0	85000. 0.0	260000. 0.0	DRAIN SY
5	100000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	100000. 0.0	THAMES

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 400000.

AFBCOAL

1979

FLUEGAS ITEM	EQMT COST	MECH ***** M A T E R I A L S *****	STRUCT	INSTRUM	INSULAT	CIVIL	ELECTR	UNSKILL	MECHAN	ELECTR	RENTAL	MATERIAL	LABOR	TOTAL	
1	73600. 0.80	14300. 0.60	6700. 0.50	0. 0.80	8500. 0.60	0. 0.50	0. 0.60	0. 0.80	3200. 0.80	0. 0.80	700. 0.60	29600. 0.0	3200. 0.0	107100. 0.0	0.00
2	763100. 0.80	28600. 0.60	0. 0.50	0. 0.80	0. 0.60	33700. 0.50	7200. 0.60	16100. 0.80	12900. 0.80	8100. 0.80	28600. 0.60	69500. 0.0	37100. 0.0	898300. 0.0	BAGHOUSE
3	262000. 0.62	158000. 0.60	80000. 0.50	80000. 0.80	235000. 0.60	8400. 0.50	108000. 0.60	45000. 0.80	150000. 0.80	55200. 0.80	13000. 0.60	660400. 0.0	250200. 0.0	1194600. 0.0	ELEC PRE
6	30300. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	30300. 0.0	LIME CRU
7	76200. 0.46	39900. 0.60	14200. 0.50	8300. 0.80	0. 0.60	7900. 0.50	9400. 0.60	15600. 0.80	35400. 0.80	7500. 0.80	6100. 0.60	73700. 0.0	58500. 0.0	220500. 0.0	LIME STI
9	100000. 0.66	17000. 0.60	0. 0.50	2400. 0.80	7000. 0.60	5000. 0.50	21600. 0.60	2800. 0.80	20000. 0.80	14400. 0.90	2500. 0.60	53000. 0.0	37200. 0.0	192700. 0.0	I.D.FAN/
10	80000. 0.60	7000. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	1500. 0.80	7000. 0.80	0. 0.80	2000. 0.60	7000. 0.0	8500. 0.0	97500. 0.0	STACK

REFERENCE SIZE= 400000.

AFBCOAL

1979

DRYASH ITEM	EQMT COST	MECH ***** M A T E R I A L S *****	STRUCT	INSTRUM	INSULAT	CIVIL	ELECTR	UNSKILL	MECHAN	ELECTR	RENTAL	MATERIAL	LABOR	TOTAL	
1	189000. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	189000. 0.0	ASH SILO
2	54300. 0.54	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	54300. 0.0	EJECTOR

TABLE C-2 (Continued)

AFB Capital Cost Data and Scaling Exponents

3	166000. 0.46	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	3. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	166000. 0.0	SEPARATO
4	69000. 0.70	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	69000. 0.0	AIR WASH
5	65700. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	65700. 0.0	VALVES/P
6	60000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	12100. 0.50	0. 0.60	3600. 0.80	0. 0.80	0. 0.80	0. 0.60	12100. 0.0	3600. 0.0	75700. 0.0	ASH TRAN
7	0. 0.0	40600. 0.60	25100. 0.50	0. 0.80	0. 0.60	18000. 0.50	22700. 0.60	79500. 0.80	226400. 0.80	21400. 0.80	47200. 0.60	106400. 0.0	327200. 0.0	490900. 0.0	ASH EQUI

REFERENCE SIZE= 400000. AFB (V) 1980

SPENTBED															
ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM MATERIALS	INSULAT *****	CIVIL *****	ELECTR *****	UNSKILL +++	MECHAN LABOR	ELECTR *++	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	237400. 0.66	3600. 0.60	0. 0.50	0. 0.80	2900. 0.60	1300. 0.50	2100. 0.60	3200. 0.80	48400. 0.80	1600. 0.80	4300. 0.60	9900. 0.0	53200. 0.0	304900. 0.0	COOLER
2	29700. 0.66	21500. 0.60	6700. 0.50	4800. 0.80	14300. 0.60	0. 0.50	0. 0.60	0. 0.80	12900. 0.80	0. 0.80	1400. 0.60	47300. 0.0	12900. 0.0	91300. 0.0	RTN
3	17800. 0.66	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	1400. 0.60	0. 0.80	1600. 0.80	800. 0.80	0. 0.60	1400. 0.0	2400. 0.0	21600. 0.0	BY EDP
4	21200. 0.66	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	1400. 0.60	0. 0.80	1600. 0.80	800. 0.80	0. 0.60	1400. 0.0	2400. 0.0	25000. 0.0	M EDP
5	17800. 0.66	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	1400. 0.60	0. 0.80	1600. 0.80	800. 0.80	0. 0.60	1400. 0.0	2400. 0.0	21600. 0.0	BY EDP

TABLE C-2 (Continued)
AFB Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 400000. AFB (T) 1980															
SPENT/BD	ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN L A B O R	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST
	1	23740. 0.66	360. 0.60	0. 0.50	0. 0.80	290. 0.60	130. 0.50	210. 0.60	320. 0.80	4840. 0.80	160. 0.80	430. 0.60	990. 0.0	5320. 0.0	30480. 0.0
	2	29700. 0.66	21500. 0.60	6700. 0.50	4800. 0.80	14300. 0.60	0. 0.50	0. 0.60	0. 0.80	12900. 0.80	0. 0.80	1400. 0.60	47300. 0.0	12900. 0.0	91300. 0.0
	3	17800. 0.66	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	1400. 0.60	0. 0.80	1600. 0.80	800. 0.80	0. 0.60	1400. 0.0	2400. 0.0	21600. 0.0
	4	21200. 0.66	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	1400. 0.60	0. 0.80	1600. 0.80	800. 0.80	0. 0.60	1400. 0.0	2400. 0.0	25000. 0.0
	5	17800. 0.66	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	1400. 0.60	0. 0.80	1600. 0.80	800. 0.80	0. 0.60	1400. 0.0	2400. 0.0	21600. 0.0

REFERENCE SIZE= 400000. AFB COAL 1980															
AFB MATS	ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN L A B O R	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST
	1	429400. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	7200. 0.60	4800. 0.80	48400. 0.80	8100. 0.80	7200. 0.60	7200. 0.0	61300. 0.0	505100. 0.0
	2	5700. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	300. 0.60	0. 0.80	3200. 0.80	300. 0.80	300. 0.60	300. 0.0	3500. 0.0	9800. 0.0
	3	6600. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	300. 0.60	0. 0.80	3200. 0.80	300. 0.80	300. 0.60	300. 0.0	3500. 0.0	10700. 0.0
	4	10000. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	400. 0.60	0. 0.80	6500. 0.80	300. 0.80	300. 0.60	400. 0.0	6900. 0.0	17500. 0.0

TABLE C-2 (Concluded)

AFB Capital Cost Data and Scaling Exponents

C-27

5	10000.	0.	5700.	0.	0.	0.	400.	0.	6500.	300.	200.	4100.	6200.	23200.	ELEV
	0.60	0.60	0.50	0.80	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	
6	25800.	0.	5400.	0.	0.	0.	0.	0.	29000.	0.	7200.	5400.	29000.	67400.	F RUNXP
	0.60	0.60	0.50	0.80	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	
7	114500.	0.	0.	0.	0.	0.	2900.	6500.	16100.	3200.	2900.	2900.	25900.	146100.	L LOP
	0.60	0.60	0.50	0.80	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	
8	357900.	0.	0.	0.	0.	0.	0.	0.	32300.	0.	8600.	0.	32300.	398800.	DISPRT
	0.60	0.60	0.50	0.80	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	
9	85900.	0.	0.	0.	0.	0.	4300.	0.	32300.	4800.	2900.	4300.	37100.	130200.	IN FOPS
	0.60	0.60	0.50	0.80	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	
10	206100.	14300.	0.	0.	0.	0.	0.	0.	80700.	0.	5700.	14300.	80700.	306800.	PIPING
	0.60	0.60	0.50	0.80	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	

Costs for other components are in 1979 dollars because the pulverized coal costs were obtained in 1979. In COSTEAM, capital costs calculated from these data tables are escalated to current year dollars using "Chemical Engineering" plant cost indices. The labor costs shown in these tables correspond to wages of 5.00, 9.00 and 11.00 dollars per hour for unskilled, mechanical (steamfitter) and electrical labor. In COSTEAM, construction labor costs are increased by the ratio of the 1980 regional wage rates in the "Engineering News Record" to these wages.

Table C-2 contains capital cost data for two AFB variants. The data for the "vendor" variant are Dr. Cox's numbers scaled to 100,000, 200,000 and 400,000 lb/hr reference plant sizes. The data for the "theory" variant contains the same capital cost data except for the AFB boiler, the superheater, and the bed materials cooler. The lower costs for these three items represent estimates for a mature AFB industry. Cost data in Table C-2 labeled AFB (V) and AFB (T) refer to the "vendor" and "theory" variants, respectively. Cost data labeled AFBCOAL apply to both variants.

APPENDIX D

OIL AND CONVENTIONAL COAL CAPITAL COST DATA

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The reference cost data used in COSTEAM for oil-fired boilers were provided by Dr. Edwin F. Coxé of Applied Energy Sciences, Inc. Budget estimates were obtained for 100,000, 200,000 and 400,000 lb/hr oil-fired boilers from the Foster-Wheeler Company. The 400,000 lb/hr boiler is field-erected, the other two are shop-fabricated.

Table D-1 contains the capital costs (upper line) and scaling exponents (lower line) for the costs of the equipment items in the reference oil-fired plants. Included in item 1 of the major boiler equipment are: tubes, ducts, burners, economizer or air heater, soot blowers, flame failure detection, support steel, gratings, forced draft fan and drive.

Instrumentation costs for the oil-fired boiler system were estimated in the following way: Costs for the feedwater control and the compressed air system are the same as for conventional coal-fired boilers. The cost of the control panel was estimated from the cost of stoker instruments. The cost of instrument installation is one-half the cost of coal-fired boiler instrument installation.

The cost of the building was set at one-half of the building cost for a conventional coal-fired boiler.

In the reference oil plant, costs and exponents for other mechanical equipment items as well as for flue gas cleanup and handling, spent sorbent transport and disposal (dry and wet) were set equal to those same costs and exponents for the conventional coal plant. The oil submodel of COSTEAM applies correction factors for flue gas and

TABLE D-1

Oil Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 100000. CONVOIL 1980

BOILER														
ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM ***	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN ***	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST
***** MATERIALS ***** + + + I A B O R + + +														
1	537000. 0.60	6600. 0.60	7200. 0.50	0. 0.80	0. 0.60	6200. 0.50	0. 0.60	6600. 0.80	23400. 0.60	0. 0.80	10000. 0.60	20000. 0.0	30000. 0.0	597000. 0.0
7	80000. 0.78	2700. 0.60	0. 0.50	0. 0.80	2900. 0.60	0. 0.50	0. 0.60	1800. 0.80	12000. 0.60	0. 0.80	3300. 0.60	5600. 0.0	13800. 0.0	102700. 0.0
11	60000. 0.55	7000. 0.60	5000. 0.50	600. 0.80	3700. 0.60	0. 0.50	960. 0.60	0. 0.80	7000. 0.80	360. 0.80	2000. 0.60	17200. 0.0	7360. 0.0	86620. 0.0

TUBES, DP
SHR HEAT
ECONOM

D-4

REFERENCE SIZE= 100000. CONVOIL 1979

MECHANIC														
ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM ***	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN ***	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST
***** MATERIALS ***** + + + I A B O R + + +														
1	25000. 0.47	3000. 0.60	0. 0.50	1000. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	3000. 0.60	0. 0.80	500. 0.60	4000. 0.0	3000. 0.0	32500. 0.0
2	70000. 0.50	10000. 0.60	5000. 0.50	6000. 0.80	10000. 0.60	2000. 0.50	3600. 0.60	1000. 0.80	22000. 0.80	1800. 0.80	4000. 0.60	36600. 0.0	24800. 0.0	135400. 0.0
3	47000. 0.60	8200. 0.60	0. 0.50	2400. 0.80	1900. 0.60	600. 0.50	3840. 0.60	300. 0.80	7000. 0.60	840. 0.80	300. 0.60	16940. 0.0	8140. 0.0	72340. 0.0
4	14000. 0.78	3600. 0.60	3200. 0.50	1200. 0.80	1400. 0.60	0. 0.50	0. 0.60	1000. 0.0	2300. 0.60	0. 0.80	800. 0.60	9400. 0.0	3300. 0.0	27500. 0.0
5	80000. 0.60	90000. 0.60	11000. 0.50	0. 0.30	33000. 0.60	0. 0.50	0. 0.60	14000. 0.80	41000. 0.80	0. 0.80	7500. 0.60	134000. 0.0	55000. 0.0	276500. 0.0
6	15000. 0.55	900. 0.60	1300. 0.50	0. 0.30	0. 0.60	0. 0.50	0. 0.60	0. 0.30	1500. 0.80	0. 0.80	200. 0.60	2700. 0.0	1500. 0.0	18000. 0.0
7	0. 0.0	5000. 0.60	0. 0.50	0. 0.80	0. 0.60	15000. 0.50	18000. 0.60	5000. 0.80	5000. 0.80	10200. 0.80	2500. 0.60	39000. 0.0	20200. 0.0	60700. 0.0
8	0. 0.0	1500. 0.60	22500. 0.50	0. 0.80	0. 0.60	4100. 0.50	6600. 0.60	4000. 0.80	7000. 0.80	3600. 0.80	4500. 0.60	34700. 0.0	14600. 0.0	53800. 0.0

DESUPER
SOFTENERS
BLR PUMP
FD W HTR
VLVS
ATP PHTP
UTILS.
BLDG SUP

TABLE D-1 (Continued)

Oil Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 100000. CONVOIL 1979

INSTRUM ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN ***	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
2	10000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	10000. 0.0	FEED CON
4	10000. 0.90	2000. 0.60	0. 0.50	0. 0.80	0. 0.60	400. 0.50	600. 0.60	0. 0.80	2000. 0.80	240. 0.80	0. 0.60	3000. 0.0	2240. 0.0	15240. 0.0	COMP AIR
9	20000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	20000. 0.0	CONTI PA
10	0. 0.0	0. 0.60	0. 0.50	1900. 0.80	0. 0.60	0. 0.50	3200. 0.60	0. 0.80	3800. 0.80	4500. 0.80	0. 0.60	5100. 0.0	9300. 0.0	13400. 0.0	INSTOM T

REFERENCE SIZE= 100000. CONVOIL 1980

FUELHAND ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN ***	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
6	4000. 0.60	2000. 0.60	0. 0.50	0. 0.80	0. 0.60	2000. 0.50	0. 0.60	1000. 0.80	1000. 0.80	0. 0.80	1000. 0.60	4000. 0.0	2000. 0.0	11000. 0.0	OIL UNIC
7	152000. 0.60	2500. 0.60	0. 0.50	0. 0.80	0. 0.60	2500. 0.50	0. 0.60	4000. 0.80	4000. 0.80	0. 0.80	4000. 0.60	5000. 0.0	8000. 0.0	169000. 0.0	OIL TAN
8	2300. 0.60	250. 0.60	0. 0.50	0. 0.80	0. 0.60	250. 0.50	0. 0.60	250. 0.80	250. 0.80	0. 0.80	100. 0.60	500. 0.0	500. 0.0	3400. 0.0	OIL HTP
9	4100. 0.60	2000. 0.60	0. 0.50	0. 0.80	0. 0.60	2000. 0.50	0. 0.60	1500. 0.80	1500. 0.80	0. 0.80	800. 0.60	4000. 0.0	3000. 0.0	11900. 0.0	PUMP STA

TABLE D-1 (Continued)

Oil Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 200000. CONVOIL 1980

BOILER

ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM ***	INSULAT MATERIALS	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN ***	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	105000. 0.60	11600. 0.60	12600. 0.50	0. 0.80	0. 0.60	10800. 0.50	0. 0.60	9900. 0.80	35100. 0.60	0. 0.80	13000. 0.60	35000. 0.60	45000. 0.0	114300. 0.0	TUBES, DR
7	150000. 0.78	5000. 0.60	0. 0.0	0. 0.0	5000. 0.60	0. 0.0	0. 0.0	3000. 0.80	20000. 0.60	0. 0.0	8000. 0.60	10000. 0.60	23000. 0.0	191000. 0.0	SUP. HTG.
11	84600. 0.60	4200. 0.60	0. 0.50	0. 0.80	7000. 0.60	0. 0.50	0. 0.60	1900. 0.80	9300. 0.80	0. 0.80	1700. 0.60	11200. 0.60	11200. 0.0	108700. 0.0	ECOV

REFERENCE SIZE= 200000. CONVOIL 1979

MECHANIC

ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM ***	INSULAT MATERIALS	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN ***	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	40000. 0.47	4800. 0.60	0. 0.0	1600. 0.80	0. 0.0	0. 0.0	0. 0.0	0. 0.80	4700. 0.60	0. 0.0	1500. 0.60	6400. 0.60	4700. 0.0	52600. 0.0	DESUPHTG
2	100000. 0.50	17000. 0.60	8000. 0.50	10000. 0.80	17000. 0.60	3500. 0.50	5880. 0.60	1600. 0.80	38000. 0.80	3600. 0.80	6500. 0.60	6180. 0.60	43200. 0.0	211000. 0.0	SOFTNESS
3	75000. 0.60	15000. 0.60	0. 0.0	4000. 0.80	3500. 0.60	1800. 0.50	6000. 0.60	1000. 0.80	25000. 0.60	2520. 0.80	2000. 0.60	30300. 0.60	28520. 0.0	135820. 0.0	PLG. PUMP
4	25000. 0.78	6000. 0.60	5000. 0.50	1800. 0.80	2200. 0.60	0. 0.0	0. 0.0	1800. 0.0	4000. 0.60	0. 0.0	1400. 0.60	15000. 0.60	5800. 0.0	47200. 0.0	FD. W. HTG
5	125000. 0.60	15000. 0.60	25000. 0.50	0. 0.80	50000. 0.60	0. 0.50	0. 0.60	25000. 0.80	75000. 0.80	0. 0.80	20000. 0.60	22500. 0.60	100000. 0.0	470000. 0.0	VALVES
6	28000. 0.55	1500. 0.60	2500. 0.50	0. 0.80	0. 0.60	500. 0.50	0. 0.60	600. 0.80	2500. 0.80	0. 0.80	2000. 0.60	4500. 0.60	3100. 0.60	37600. 0.0	ALCOHTG

TABLE D-1 (Continued)

Oil Capital Cost Data and Scaling Exponents

7	0. 0.0	9000. 0.50	0. 0.50	0. 0.80	0. 0.60	26000. 0.50	31200. 0.60	9000. 0.80	9000. 0.80	19000. 0.80	4300. 0.60	64200. 0.0	36000. 0.0	106500. 0.0	UTILITIES
8	0. 0.0	2500. 0.60	40000. 0.50	0. 0.0	0. 0.60	7500. 0.50	12000. 0.60	7500. 0.80	12500. 0.80	6600. 0.90	8500. 0.60	62000. 0.0	26000. 0.0	97100. 0.0	PUMP STATION

REFERENCE SIZE= 200000. CONVOIL 1979

INSTRUM ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM MATERIALS	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL +++	MECHAN LABOR	ELECTR +++	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
2	15000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	15000. 0.0	FEED CON
4	17000. 0.90	3500. 0.60	0. 0.50	0. 0.80	0. 0.60	700. 0.50	1080. 0.60	0. 0.80	3400. 0.80	480. 0.80	0. 0.60	5280. 0.0	3880. 0.0	26160. 0.0	COND AP
9	30000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	30000. 0.0	OIL TAN
10	0. 0.0	5600. 0.60	0. 0.50	5600. 0.80	0. 0.60	0. 0.50	2300. 0.60	0. 0.80	28100. 0.80	13500. 0.80	0. 0.0	13500. 0.0	41600. 0.0	55100. 0.0	INST. IN

REFERENCE SIZE= 200000. CONVOIL 1980

FUELHAND ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM MATERIALS	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL +++	MECHAN LABOR	ELECTR +++	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
6	6000. 0.60	2750. 0.60	0. 0.50	0. 0.80	0. 0.60	2750. 0.50	0. 0.60	1750. 0.80	1750. 0.80	0. 0.80	1500. 0.60	5500. 0.0	3500. 0.0	16500. 0.0	OIL UNLO
7	306000. 0.60	5000. 0.60	0. 0.50	0. 0.80	0. 0.60	5000. 0.50	0. 0.60	7000. 0.80	7000. 0.80	0. 0.80	6000. 0.60	10000. 0.0	14000. 0.0	336000. 0.0	OIL TAN
8	4600. 0.60	300. 0.60	0. 0.50	0. 0.80	0. 0.60	300. 0.50	0. 0.60	300. 0.80	300. 0.80	0. 0.80	100. 0.60	600. 0.0	600. 0.0	5800. 0.0	OIL MTR
9	5500. 0.60	2250. 0.60	0. 0.50	0. 0.80	0. 0.60	2250. 0.50	0. 0.60	1750. 0.80	1750. 0.80	0. 0.80	1000. 0.60	4500. 0.0	3500. 0.0	14500. 0.0	PUMP STA

TABLE D-1 (Continued)

Oil Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 400000.

CONVOIL

1980

BOILER

ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM MATERIALS	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL LABOR	MECHAN LABOR	ELECTR LABOR	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	175000. 0.60	38000. 0.60	14000. 0.50	0. 0.80	0. 0.60	31000. 0.50	0. 0.60	113000. 0.80	386000. 0.60	0. 0.80	67000. 0.60	83700. 0.0	490000. 0.0	2399000. 0.0	TUBES, 22
7	250000. 0.78	8000. 0.60	0. 0.0	0. 0.0	8000. 0.60	0. 0.0	0. 0.0	5000. 0.80	34000. 0.60	0. 0.0	13000. 0.60	16000. 0.0	39000. 0.0	318000. 0.0	SHR HEAT
11	128200. 0.60	6400. 0.60	0. 0.50	0. 0.80	10500. 0.60	0. 0.50	0. 0.60	3200. 0.80	16100. 0.80	0. 0.80	2600. 0.60	16000. 0.0	19300. 0.0	167000. 0.0	BOILER

REFERENCE SIZE= 400000.

CONVOIL

1979

MECHANIC

ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM MATERIALS	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL LABOR	MECHAN LABOR	ELECTR LABOR	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	65000. 0.47	7600. 0.60	0. 0.0	3000. 0.80	0. 0.0	0. 0.0	0. 0.0	0. 0.80	8600. 0.60	0. 0.0	2500. 0.60	10610. 0.0	9600. 0.0	86700. 0.0	DESUPER
2	175000. 0.50	26000. 0.60	14000. 0.50	15000. 0.80	25000. 0.60	6000. 0.50	9600. 0.60	24000. 0.80	65000. 0.80	7200. 0.80	10000. 0.60	95680. 0.0	96200. 0.0	376800. 0.0	SOFTENERS
3	135000. 0.60	29000. 0.60	0. 0.0	7000. 0.80	6200. 0.60	3400. 0.50	11400. 0.60	1800. 0.80	45000. 0.60	4800. 0.80	4000. 0.60	57000. 0.0	51600. 0.0	247600. 0.0	BLR PUMP
4	40000. 0.78	10000. 0.60	8000. 0.50	3200. 0.80	3500. 0.60	0. 0.0	0. 0.0	3400. 0.0	6500. 0.60	0. 0.0	2300. 0.60	24700. 0.0	9200. 0.0	76200. 0.0	FD M. HT
5	215000. 0.60	260000. 0.60	45000. 0.50	0. 0.80	90000. 0.60	0. 0.50	0. 0.60	4500. 0.80	130000. 0.80	0. 0.80	40000. 0.60	395000. 0.0	134500. 0.0	784500. 0.0	VALVES
6	50000. 0.55	2200. 0.60	4000. 0.50	0. 0.80	0. 0.60	800. 0.50	0. 0.60	1000. 0.80	4500. 0.80	0. 0.80	3500. 0.60	7000. 0.0	5500. 0.0	66000. 0.0	ATOPHTS
7	0. 0.0	15000. 0.60	0. 0.50	0. 0.80	0. 0.60	50000. 0.50	60000. 0.60	17000. 0.80	17000. 0.80	33600. 0.80	7000. 0.60	125000. 0.0	67600. 0.0	129600. 0.0	UTILS.

TABLE D-1 (Concluded)

Oil Capital Cost Data and Scaling Exponents

8	0.	4000.	70000.	0.	0.	13000.	22200.	14000.	22500.	12000.	15000.	130000.	48500.	177700.	6100000.
	0.0	0.60	0.50	0.0	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	

REFERENCE SIZE= 400000. CONVOIL 1979

INSTRUM ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM MATERIALS	INSULAT S	CIVIL *****	ELECTR *****	UNSKILL +++	MECHAN LABOR	ELECTR +++	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
2	15000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	15000. 0.0	FEED CON
4	28000. 0.90	6000. 0.60	0. 0.50	0. 0.80	0. 0.60	1100. 0.50	1680. 0.60	0. 0.80	5300. 0.80	940. 0.80	0. 0.60	8780. 0.0	6140. 0.0	42920. 0.0	COMP AIR
9	40000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	40000. 0.0	OIL TAN
10	0. 0.0	7500. 0.60	0. 0.50	7500. 0.80	0. 0.60	0. 0.50	4500. 0.60	0. 0.80	37500. 0.80	18000. 0.80	0. 0.0	19500. 0.0	55500. 0.0	75000. 0.0	INSTRUM

REFERENCE SIZE= 400000. CONVOIL 1980

FUELHAND ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM MATERIALS	INSULAT S	CIVIL *****	ELECTR *****	UNSKILL +++	MECHAN LABOR	ELECTR +++	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
6	8000. 0.60	3250. 0.60	0. 0.50	0. 0.80	0. 0.60	3250. 0.50	0. 0.60	2250. 0.80	2250. 0.80	0. 0.80	2000. 0.60	6500. 0.0	4500. 0.0	21000. 0.0	OIL UNLO
7	612000. 0.60	7500. 0.60	0. 0.50	0. 0.80	0. 0.60	7500. 0.50	0. 0.60	10000. 0.80	10000. 0.80	0. 0.80	8000. 0.60	15000. 0.0	20000. 0.0	650000. 0.0	OIL TAN
8	9100. 0.60	400. 0.60	0. 0.50	0. 0.80	0. 0.60	400. 0.50	0. 0.60	400. 0.80	400. 0.80	0. 0.80	100. 0.60	800. 0.0	800. 0.0	10800. 0.0	OIL HTR
9	10900. 0.60	3000. 0.60	0. 0.50	0. 0.80	0. 0.60	3000. 0.50	0. 0.60	2250. 0.80	2250. 0.80	0. 0.80	1500. 0.60	6000. 0.0	4500. 0.0	22900. 0.0	COMP STA

materials flow rates relative to flows in the reference conventional coal plants. Table D-2 contains the capital costs (upper line) and scaling exponents (lower line) for the reference conventional coal-fired steam plants.

TABLE D-2

Conventional Coal Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 100000. STOKER 1979

BOILER ITEM	EQMT COST	MECH ***	STRUCT *****	INSTRUM M A T E R I A L S	INSULAT *****	CIVIL *****	ELECTR *****	UNSKILL + + +	MECHAN L A B O R	ELECTR + + +	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	542500. 0.60	23300. 0.60	25600. 0.50	0. 0.80	74400. 0.60	21700. 0.50	0. 0.60	60500. 0.80	279000. 0.60	0. 0.80	40300. 0.60	145000. 0.0	339500. 0.0	1067300. 0.0	TUBES, DR
2	0. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	0. 0.0	GRINDERS
3	0. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	0. 0.0	OIL IGN.
4	0. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	0. 0.0	PULV. FAN
5	0. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	0. 0.0	CL EGGS.
6	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	FUEL FLOW
7	124000. 0.78	4200. 0.60	0. 0.50	0. 0.80	4500. 0.60	0. 0.50	0. 0.60	2800. 0.80	18600. 0.60	0. 0.80	5100. 0.60	8700. 0.0	21400. 0.0	150200. 0.0	SUP HEAT
8	31000. 0.54	1900. 0.60	0. 0.50	0. 0.80	900. 0.60	0. 0.50	1700. 0.60	1100. 0.80	3600. 0.80	1100. 0.80	0. 0.60	4500. 0.0	5800. 0.0	41300. 0.0	SOOT BL
9	26400. 0.66	4300. 0.60	0. 0.50	1400. 0.80	2500. 0.60	1400. 0.50	5400. 0.60	1100. 0.80	1000. 0.80	1700. 0.80	300. 0.60	15000. 0.0	4700. 0.0	46400. 0.0	F.D. FAN
10	93000. 0.55	10900. 0.60	7800. 0.50	900. 0.80	5700. 0.60	0. 0.50	1500. 0.60	0. 0.80	10900. 0.80	600. 0.80	3100. 0.60	26900. 0.0	11500. 0.0	134400. 0.0	AIR HTF
12	155000. 0.60	11500. 0.60	3900. 0.0	0. 0.80	0. 0.60	0. 0.50	6000. 0.60	1900. 0.80	26400. 0.80	3300. 0.80	2800. 0.60	21500. 0.0	31600. 0.0	210000. 0.0	S. STOVE
14	11600. 0.0	2300. 0.60	4700. 0.0	2800. 0.80	0. 0.60	0. 0.50	4700. 0.60	2300. 0.0	18600. 0.80	2800. 0.80	3100. 0.0	14500. 0.0	23700. 0.0	52000. 0.0	CL SCALE

D-11

TABLE D-2 (Continued)

Conventional Coal Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 100000.

PUL.COAL

1979

BOILER ITEM	EQUIP COST	MECH *****	STRUCT M A T E R I A L S	INSTRUM *****	INSULAT L S *****	CIVIL *****	ELECTR *****	UNSKILL *****	MECHAN *****	ELECTR *****	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	542500. 0.60	20200. 0.60	10100. 0.50	0. 0.80	74400. 0.60	21700. 0.50	0. 0.60	60500. 0.80	217000. 0.60	0. 0.80	35700. 0.60	126400. 0.0	277500. 0.0	982100. 0.0	THREES.D2
2	34100. 0.60	4700. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	6200. 0.80	0. 0.80	300. 0.60	4700. 0.0	6200. 0.0	45300. 0.0	BURNERS
3	9100. 0.0	1700. 0.60	0. 0.50	0. 0.80	500. 0.60	0. 0.60	1300. 0.60	0. 0.80	2300. 0.80	600. 0.80	0. 0.0	3500. 0.0	2900. 0.0	15500. 0.0	CH.IGN.
4	217000. 0.60	20200. 0.60	0. 0.0	0. 0.80	5000. 0.60	2600. 0.50	6000. 0.60	1900. 0.80	26400. 0.80	3300. 0.80	1700. 0.60	23900. 0.0	31600. 0.0	204100. 0.0	PUMPERS
5	37200. 0.0	5000. 0.60	0. 0.0	2800. 0.80	0. 0.0	1400. 0.50	1500. 0.60	0. 0.0	7000. 0.80	1100. 0.80	900. 0.60	10700. 0.0	8100. 0.0	56900. 0.0	CL.EDRS.
6	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	FUEL.IGN.
7	124000. 0.78	4200. 0.60	0. 0.0	0. 0.0	4500. 0.60	0. 0.0	0. 0.0	2800. 0.80	18600. 0.60	0. 0.0	5100. 0.60	8700. 0.0	21400. 0.0	159200. 0.0	SUPHEATE
8	31000. 0.54	1900. 0.60	0. 0.0	0. 0.0	900. 0.60	0. 0.0	1700. 0.60	1100. 0.80	3600. 0.80	1100. 0.80	0. 0.60	4500. 0.0	5200. 0.0	41300. 0.0	SODIUMS.
9	26400. 0.66	4300. 0.60	0. 0.0	1400. 0.80	2500. 0.60	1400. 0.50	5400. 0.60	1100. 0.80	1900. 0.80	1700. 0.80	300. 0.60	15000. 0.0	4700. 0.0	46400. 0.0	F.O.FAN
10	93000. 0.55	10900. 0.60	7800. 0.50	900. 0.80	5700. 0.60	0. 0.50	1500. 0.60	0. 0.80	10900. 0.80	600. 0.80	3100. 0.60	26800. 0.0	11500. 0.0	134400. 0.0	AIR.HTD.
12	0. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	0. 0.0	STOKER

D-12

TABLE D-2 (Continued)

Conventional Coal Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 100000. STOKER 1979

MECHANIC ITEM	EOMT COST	MECH ***	STUCT ***	INSTRUM M A T E R I A L S	INSULAT P I A L S	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN L A B O R	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	25000. 0.47	3000. 0.60	0. 0.50	1000. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	3000. 0.60	0. 0.80	500. 0.60	4000. 0.0	3000. 0.0	32500. 0.0	DESUPER
2	70000. 0.50	10000. 0.60	5000. 0.50	6000. 0.80	10000. 0.60	2000. 0.50	3600. 0.60	1000. 0.80	22000. 0.80	1800. 0.80	4000. 0.60	36600. 0.0	24800. 0.0	135400. 0.0	SOFTWARE
3	47000. 0.60	8200. 0.60	0. 0.50	2400. 0.80	1900. 0.60	600. 0.50	3840. 0.60	300. 0.80	7000. 0.60	840. 0.80	300. 0.60	16940. 0.0	8140. 0.0	72390. 0.0	BLD BLDG
4	14000. 0.73	3600. 0.60	3200. 0.50	1200. 0.80	1400. 0.60	0. 0.50	0. 0.60	1000. 0.0	2300. 0.60	0. 0.80	800. 0.60	9400. 0.0	3300. 0.0	27500. 0.0	FD W HTS
5	80000. 0.60	90000. 0.60	11000. 0.50	0. 0.80	33000. 0.60	0. 0.50	0. 0.60	14000. 0.80	41000. 0.80	0. 0.80	7500. 0.60	134000. 0.0	55000. 0.0	276500. 0.0	VIVS
6	15000. 0.55	900. 0.60	1300. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	1500. 0.80	0. 0.80	200. 0.60	2200. 0.0	1500. 0.0	18200. 0.0	ATS BHTP
7	0. 0.0	5000. 0.60	0. 0.50	0. 0.80	0. 0.60	15000. 0.50	18000. 0.60	5000. 0.80	5000. 0.80	10200. 0.80	2500. 0.60	38100. 0.0	20200. 0.0	60700. 0.0	HTLS.
8	0. 0.0	3000. 0.60	45000. 0.50	0. 0.80	0. 0.60	8200. 0.50	13200. 0.60	8000. 0.80	14000. 0.80	7200. 0.80	9000. 0.60	69400. 0.0	29200. 0.0	107600. 0.0	BLDG SHD

D-13

TABLE D-2 (Continued)

Conventional Coal Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 100000. PUL.COAL 1979

MECHANIC ITEM	EQUIP COST	MECH ***	STRUCT ***	INSTRUM MATERIALS	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN LABOR	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	25000. 0.47	3100. 0.60	0. 0.0	900. 0.80	0. 0.0	0. 0.0	0. 0.0	0. 0.80	3200. 0.60	0. 0.0	600. 0.60	4900. 0.0	3200. 0.0	32800. 0.0	DESUPER
2	70000. 0.50	10000. 0.60	5000. 0.50	6000. 0.80	10000. 0.60	2000. 0.50	3600. 0.60	1000. 0.80	22000. 0.80	1800. 0.90	4000. 0.60	34600. 0.0	24800. 0.0	125400. 0.0	COFINES
3	47000. 0.60	8200. 0.60	0. 0.0	2400. 0.80	1900. 0.60	600. 0.50	3840. 0.60	300. 0.80	7000. 0.60	840. 0.80	300. 0.60	15940. 0.0	2140. 0.0	72720. 0.0	BLPUMP
4	14000. 0.78	3600. 0.60	3200. 0.50	1200. 0.80	1400. 0.60	0. 0.0	0. 0.0	1000. 0.0	2300. 0.60	0. 0.0	800. 0.60	3400. 0.0	3300. 0.0	27500. 0.0	SEEDHTR
5	80000. 0.60	90000. 0.60	11000. 0.50	0. 0.80	33000. 0.60	0. 0.50	0. 0.60	14000. 0.80	41000. 0.80	0. 0.80	7500. 0.60	134000. 0.0	55000. 0.0	276500. 0.0	VALVES
6	15000. 0.55	900. 0.60	1300. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	1500. 0.80	0. 0.80	200. 0.60	2200. 0.0	1500. 0.0	19900. 0.0	AIR PWR
7	0. 0.0	5000. 0.60	0. 0.50	0. 0.80	0. 0.60	15000. 0.50	18000. 0.60	5000. 0.80	5000. 0.80	10200. 0.80	2500. 0.60	39200. 0.0	20200. 0.0	60700. 0.0	HTTL
8	0. 0.0	3000. 0.60	45000. 0.50	0. 0.0	0. 0.60	8200. 0.50	13200. 0.60	8000. 0.80	14000. 0.80	7200. 0.80	9000. 0.60	65100. 0.0	29200. 0.0	107600. 0.0	BLD SUP

D-14

TABLE D-2 (Continued)

Conventional Coal Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 100000.

STOKER

1979

D-15

INSTRUM ITEM	EQMT COST	MECH *****	STRUCT *****	INSTRUM M A T E R I A L S *****	INSULAT *****	CIVIL *****	ELECTR *****	UNSKILL *****	MECHAN *****	ELECTR *****	PENTAL *****	MATERIAL *****	LABOR *****	TOTAL COST	
1	5000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	5000. 0.0	UNDER AT
2	10000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	10000. 0.0	FEED CON
3	5000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	5000. 0.0	OVER AIR
4	10000. 0.90	2000. 0.60	0. 0.50	0. 0.80	0. 0.60	400. 0.50	600. 0.60	0. 0.80	2000. 0.80	240. 0.80	0. 0.60	3000. 0.0	2740. 0.0	15240. 0.0	COND AIR
5	10000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	10000. 0.0	CONV. CON
6	10000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	10000. 0.0	FUEL CON
7	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	CONV. CON
8	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	BURN NGV
9	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	CONTI PA
10	0. 0.0	0. 0.60	0. 0.50	5000. 0.80	0. 0.60	0. 0.50	8400. 0.60	0. 0.80	10000. 0.80	12000. 0.80	0. 0.60	13400. 0.0	22000. 0.0	35400. 0.0	INSTRUM

TABLE D-2 (Continued)

Conventional Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 100000. PUL.COAL 1779

INSTRUM ITEM	FOOT COST	MECH ***	STRUCT ***	INSTRUM MATERIALS	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN LABOR	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	UNDER AT
2	10000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	10000. 0.0	FUEL CON
3	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	OVER AT
4	10000. 0.90	2000. 6.60	0. 0.50	0. 0.80	0. 0.60	400. 0.50	600. 0.60	0. 0.80	2000. 0.80	240. 0.80	0. 0.60	3000. 0.0	2240. 0.0	15240. 0.0	COND AIR
5	10000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	10000. 0.0	CONT PAN
6	10000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	10000. 0.0	FUEL CON
7	40000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	40000. 0.0	COND CON
8	75000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	75000. 0.0	BURN MGR
9	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	CONT PAN
10	0. 0.0	15000. 0.60	0. 0.50	15000. 0.80	0. 0.60	0. 0.50	6000. 0.60	0. 0.80	75000. 0.80	36000. 0.80	0. 0.0	36000. 0.0	111000. 0.0	147000. 0.0	INSTRUM I

TABLE D-2 (Continued)

Conventional Coal Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 100000. CONVCOAL 1979

FUELHAND ITEM	EQMT COST	MECH *****	STRUCT *****	INSTRUM *****	INSULAT *****	CIVIL *****	ELECTR *****	UNSKILL *****	MECHAN *****	ELECTR *****	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	75000. 0.25	5000. 0.60	5000. 0.50	0. 0.80	0. 0.60	5000. 0.50	6000. 0.60	6700. 0.80	21000. 0.80	5760. 0.80	6600. 0.60	21000. 0.0	32940. 0.0	135560. 0.0	UNLOADED
2	36000. 0.40	0. 0.60	0. 0.50	0. 0.80	0. 0.60	3200. 0.50	0. 0.60	2700. 0.80	0. 0.80	0. 0.80	0. 0.60	3200. 0.0	2700. 0.0	41000. 0.0	COAL SI
3	72500. 1.00	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	72500. 0.0	PAUL SPS
4	25000. 1.00	0. 0.60	0. 0.50	0. 0.80	0. 0.60	15000. 0.50	0. 0.60	17000. 0.80	13000. 0.80	0. 0.80	10000. 0.60	15000. 0.0	25000. 0.0	75000. 0.0	GRAIN SY
5	25000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	25000. 0.0	THAWEP

REFERENCE SIZE= 100000. CONVCOAL 1979

FLUEGAS ITEM	EQMT COST	MECH *****	STRUCT *****	INSTRUM *****	INSULAT *****	CIVIL *****	ELECTR *****	UNSKILL *****	MECHAN *****	ELECTR *****	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	25000. 0.80	3500. 0.60	0. 0.50	0. 0.80	2500. 0.60	500. 0.50	0. 0.60	1700. 0.80	4500. 0.80	0. 0.80	500. 0.60	6500. 0.0	5700. 0.0	37700. 0.0	DUST COI
2	160000. 0.80	30000. 0.60	15000. 0.50	18000. 0.80	35000. 0.60	3070. 0.50	14400. 0.60	17000. 0.80	50000. 0.80	9600. 0.80	11000. 0.60	115400. 0.0	76400. 0.0	363000. 0.0	SACHOUSE
3	145000. 0.62	54000. 0.60	18000. 0.50	27000. 0.80	55000. 0.60	2000. 0.50	28800. 0.60	10000. 0.80	50000. 0.80	18000. 0.80	3000. 0.60	184800. 0.0	78000. 0.0	410800. 0.0	ELEC OPS
4	85000. 0.56	17500. 0.60	11000. 0.50	2500. 0.80	8500. 0.60	7000. 0.50	4800. 0.60	25000. 0.80	40000. 0.80	9600. 0.80	4000. 0.60	51300. 0.0	74600. 0.0	214000. 0.0	WETBICA

TABLE D-2 (Continued)

Conventional Coal Capital Cost Data and Scaling Exponents

5	295000.	55000.	27000.	8000.	22000.	5000.	3600.	25000.	35000.	6500.	18000.	120000.	64000.	498000.	DEVELOP
	0.64	0.60	0.50	0.80	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	
6	8700.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	8700.	LIVE SH
	0.60	0.60	0.50	0.80	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	
7	10000.	5000.	2000.	2000.	0.	1500.	1800.	2500.	5000.	1440.	1000.	12000.	8500.	32000.	LIVE SH
	0.46	0.60	0.50	0.80	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	
8	5000.	500.	0.	0.	0.	300.	600.	0.	2000.	300.	200.	1400.	2300.	8500.	LIVE TAN
	0.66	0.60	0.50	0.80	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	
9	35000.	5500.	0.	1500.	3000.	1600.	7200.	1000.	7500.	4800.	1000.	18000.	13000.	60000.	L.O.FAN/
	0.66	0.60	0.50	0.80	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	
10	20000.	2500.	0.	0.	0.	0.	0.	500.	2500.	0.	800.	2500.	3000.	26000.	STACK
	0.50	0.60	0.50	0.80	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	
REFERENCE SIZE= 100000. CONVCOAL 1979															

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DRYASH															
ITEM	EQMT CCST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL + + +	MECHAN L A B O R	ELECTR + + +	RENTAL CCST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	30000. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	30000. 0.0	ASH SILE
2	10000. 0.54	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	10000. 0.0	EJECTOR
3	30000. 0.46	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	30000. 0.0	SEPARATO
4	10000. 0.70	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	10000. 0.0	AIR WASH
5	10000. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	10000. 0.0	VALVE/P
6	25000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	2500. 0.50	0. 0.60	500. 0.80	0. 0.80	0. 0.80	0. 0.60	2500. 0.0	500. 0.0	28000. 0.0	ASH TRAN
7	0. 0.0	6000. 0.60	4000. 0.50	0. 0.80	0. 0.60	3500. 0.50	3600. 0.60	5000. 0.80	25000. 0.80	2400. 0.80	6000. 0.60	17100. 0.0	36400. 0.0	59500. 0.0	ASH BOTT

TABLE D-2 (Continued)

Conventional Coal Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 100000. CONVCOAL 1979

WETASH ITEM	EQMT COST	MECH ***	STRUCT *****	INSTRUM M A T E R I A L S	INSULAT *****	CIVIL *****	ELECTP *****	UNSKILL + + +	MECHAN L A B O R	ELECTR + + +	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	5000. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	6000. 0.0	0.45000
2	6000. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	6000. 0.0	0.45000
3	10000. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	10000. 0.0	0.45000
4	2000. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	2000. 0.0	0.45000
5	2000. 0.41	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	2000. 0.0	0.45000
6	0. 0.0	2000. 0.60	0. 0.50	0. 0.80	0. 0.60	2400. 0.50	4680. 0.60	28000. 0.80	10000. 0.80	2280. 0.80	2600. 0.60	6000. 0.0	40280. 0.0	51680. 0.0	0.45000
7	70000. 0.46	6500. 0.60	4400. 0.50	0. 0.80	2100. 0.60	1200. 0.50	960. 0.60	5000. 0.80	20000. 0.80	1440. 0.80	2400. 0.60	15100. 0.0	26440. 0.0	114000. 0.0	0.45000
8	35000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	35000. 0.0	0.45000
9	0. 0.46	24000. 0.60	0. 0.50	0. 0.80	0. 0.60	6000. 0.50	0. 0.60	8000. 0.80	10000. 0.80	0. 0.80	27000. 0.60	30000. 0.0	18000. 0.0	75000. 0.0	0.45000

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TABLE D-2 (Continued)

Conventional Coal Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 200000.

PUL.COAL

1979

BOILER ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM MATERIALS	INSULAT ***	CIVIL *****	ELECTR *****	UNSKILL +++	MECHAN LABOR	ELECTR +++	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	930000. 0.60	38800. 0.60	15500. 0.50	0. 0.80	124000. 0.60	31000. 0.50	0. 0.60	116300. 0.80	387500. 0.60	0. 0.80	69800. 0.60	200300. 0.0	503800. 0.0	1712000. 0.0	THREE, 00
2	55800. 0.60	7800. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	9300. 0.80	0. 0.80	2500. 0.60	7800. 0.0	9300. 0.0	75400. 0.0	BURNERS
3	11600. 0.0	3100. 0.60	0. 0.50	0. 0.80	800. 0.60	0. 0.50	1300. 0.60	0. 0.80	3900. 0.80	600. 0.80	0. 0.0	5200. 0.0	4500. 0.0	21300. 0.0	ONE, 10
4	348800. 0.60	38800. 0.60	0. 0.0	0. 0.80	10900. 0.60	4700. 0.50	9300. 0.60	3900. 0.80	46500. 0.80	5600. 0.80	3100. 0.60	63700. 0.0	56000. 0.0	471600. 0.0	DRUM, CAN
5	55800. 0.0	9300. 0.60	0. 0.0	4700. 0.80	0. 0.0	2300. 0.50	2800. 0.60	0. 0.0	12400. 0.80	2200. 0.80	2800. 0.60	10100. 0.0	14600. 0.0	92200. 0.0	CL. FORD
6	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	FUEL, 100
7	232500. 0.78	7800. 0.60	0. 0.0	0. 0.0	7800. 0.60	0. 0.0	0. 0.0	4700. 0.80	31000. 0.60	0. 0.0	12400. 0.60	15600. 0.0	35700. 0.0	296200. 0.0	SUP. HTP.
8	46500. 0.54	3100. 0.60	0. 0.0	0. 0.0	1600. 0.60	0. 0.0	2800. 0.60	1900. 0.80	5200. 0.80	1900. 0.80	0. 0.60	7500. 0.0	10000. 0.0	64000. 0.0	SOOT, 100
9	46500. 0.66	7800. 0.60	0. 0.0	2300. 0.80	3900. 0.60	3100. 0.50	7400. 0.60	1900. 0.80	4700. 0.80	3200. 0.80	1600. 0.60	24500. 0.0	9800. 0.0	82400. 0.0	F.O. FAN
10	158100. 0.55	18600. 0.60	14000. 0.50	1600. 0.80	10100. 0.60	0. 0.0	2800. 0.60	0. 0.80	19600. 0.80	900. 0.80	9300. 0.60	47100. 0.0	19500. 0.0	234000. 0.0	AIR HTP.
12	0. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	0. 0.0	STOKER

D-20

TABLE D-2 (Continued)

Conventional Coal Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 200000. PUL.COAL 1979

MECHANIC	ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL + + +	MECHAN L A B O R	ELECTR + + +	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
	1	40000. 0.47	4800. 0.60	0. 0.0	1600. 0.80	0. 0.0	0. 0.0	0. 0.0	0. 0.80	4700. 0.60	0. 0.0	1500. 0.60	4400. 0.0	4700. 0.0	52600. 0.0	DESIGNER
	2	100000. 0.50	17000. 0.60	8000. 0.50	10000. 0.80	17000. 0.60	3500. 0.50	5880. 0.60	1600. 0.80	38000. 0.80	3600. 0.80	6500. 0.60	61380. 0.0	43200. 0.0	211080. 0.0	SOFTWARES
	3	75000. 0.60	15000. 0.60	0. 0.0	4000. 0.80	3500. 0.60	1800. 0.50	6000. 0.60	1000. 0.80	25000. 0.60	2520. 0.80	2000. 0.60	30300. 0.0	29520. 0.0	135920. 0.0	PLP.D.M.P
	4	25000. 0.78	6000. 0.60	5000. 0.50	1800. 0.80	2200. 0.60	0. 0.0	0. 0.0	1800. 0.0	4000. 0.60	0. 0.0	1400. 0.60	15000. 0.0	5800. 0.0	47200. 0.0	ED.W.B.C
	5	125000. 0.60	150000. 0.60	25000. 0.50	0. 0.80	50000. 0.60	0. 0.50	0. 0.60	25000. 0.80	75000. 0.80	0. 0.80	20000. 0.60	225000. 0.0	100000. 0.0	470000. 0.0	VALVES
	6	28000. 0.55	1500. 0.60	2500. 0.50	0. 0.80	0. 0.60	500. 0.50	0. 0.60	600. 0.80	2500. 0.80	0. 0.80	2000. 0.60	4500. 0.0	3100. 0.0	37600. 0.0	ALPHABET
	7	0. 0.0	9000. 0.60	0. 0.50	0. 0.80	0. 0.60	26000. 0.50	31200. 0.60	9000. 0.80	9000. 0.80	18000. 0.80	4300. 0.60	66200. 0.0	36000. 0.0	106500. 0.0	UTILITY
	8	0. 0.0	5000. 0.60	80000. 0.50	0. 0.0	0. 0.60	15000. 0.50	24000. 0.60	15000. 0.80	25000. 0.80	13200. 0.80	17000. 0.60	124000. 0.0	53200. 0.0	194200. 0.0	BIOS.SUP

TABLE D-2 (Continued)

Conventional Coal Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 200000.

PUL.COAL

1979

INSTRUM ITEM	ECMT COST	MECH *****	STRUCT *****	INSTRUM M A T E R I A L S	INSULAT *****	CIVIL *****	ELECTR *****	UNSKILL *****	MECHAN *****	ELECTR *****	RENTAL *****	MATERIAL *****	LABOR *****	TOTAL *****	
1	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	UNDER 10
2	15000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	15000. 0.0	FEED CON
3	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	OVER 100
4	17000. 0.90	3500. 0.60	0. 0.50	0. 0.80	0. 0.60	700. 0.50	1080. 0.60	0. 0.80	34000. 0.80	480. 0.80	0. 0.60	5200. 0.0	34480. 0.0	56760. 0.0	CRUD AIR
5	10000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	10000. 0.0	COND. AIR
6	10000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	10000. 0.0	FUEL CON
7	40000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	40000. 0.0	COND. CON
8	75000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	75000. 0.0	COND. AIR
9	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	DEL PAN
10	0. 0.0	15000. 0.60	0. 0.50	15000. 0.80	0. 0.60	0. 0.50	6000. 0.60	0. 0.80	75000. 0.90	36000. 0.80	0. 0.0	36000. 0.0	111000. 0.0	147000. 0.0	INST. IN

D-22

TABLE D-2 (Continued)

Conventional Coal Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 200000. CONVCOAL 1979

FUELHAND ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN LABOR	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	75000. 0.25	5000. 0.60	9000. 0.50	0. 0.80	0. 0.60	9500. 0.50	10440. 0.60	7800. 0.80	34000. 0.80	9960. 0.80	9200. 0.60	33940. 0.0	51760. 0.0	169900. 0.0	UNLOADIN
2	56000. 0.46	0. 0.0	0. 0.0	0. 0.0	0. 0.0	5000. 0.50	0. 0.0	4000. 0.80	0. 0.0	0. 0.0	0. 0.60	5000. 0.0	4000. 0.0	65000. 0.0	COAL SIL
3	150000. 1.00	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	150000. 0.0	RAIL SPI
4	50000. 1.00	0. 0.60	0. 0.50	0. 0.80	0. 0.60	27000. 0.50	0. 0.60	21000. 0.80	23000. 0.80	0. 0.80	17500. 0.60	27000. 0.0	44000. 0.0	138500. 0.0	DRAIN SY
5	50000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	50000. 0.0	TOWER

REFERENCE SIZE= 200000. CONVCOAL 1979

FLUEGAS ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN LABOR	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	43000. 0.80	6700. 0.60	0. 0.50	0. 0.80	4600. 0.60	900. 0.50	0. 0.60	2200. 0.80	8300. 0.80	0. 0.80	900. 0.60	12200. 0.0	10500. 0.0	66600. 0.0	DUST COL
2	307000. 0.80	70000. 0.60	35000. 0.50	35000. 0.80	60000. 0.60	5500. 0.50	24000. 0.60	32000. 0.80	100000. 0.80	15600. 0.80	20000. 0.60	279500. 0.0	147600. 0.0	704100. 0.0	BAGHOUSE
3	265000. 0.62	100000. 0.60	40000. 0.50	50000. 0.80	107000. 0.60	4000. 0.50	48000. 0.60	27000. 0.80	85000. 0.80	33600. 0.80	7000. 0.60	349000. 0.0	145600. 0.0	766600. 0.0	ELEC. PRE
4	158000. 0.56	33000. 0.60	20000. 0.50	5200. 0.80	15000. 0.60	12000. 0.50	8640. 0.60	43000. 0.80	71000. 0.80	18000. 0.80	11000. 0.60	93840. 0.0	132000. 0.0	394840. 0.0	W FLUEGAS

TABLE D-2 (Continued)

Conventional Coal Capital Cost Data and Scaling Exponents

5	580000.	90000.	45000.	13000.	40000.	8000.	6000.	43000.	65000.	8400.	29000.	202000.	116400.	927400.	0 FLUGAS
	0.64	0.60	0.50	0.80	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	
6	13200.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	13200.	LIME CRU
	0.60	0.60	0.50	0.80	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	
7	20000.	10000.	4000.	4000.	0.	3000.	3400.	5000.	10000.	2800.	2000.	24600.	17880.	64480.	LIME SIL
	0.46	0.60	0.50	0.80	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	
8	10000.	1000.	0.	0.	0.	600.	1200.	0.	4000.	720.	400.	2800.	4720.	17020.	LIME TAN
	0.66	0.60	0.50	0.80	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	
9	60000.	10000.	0.	1800.	4500.	3000.	13200.	1500.	12000.	8400.	1500.	32500.	21000.	115900.	I.O.FAN/
	0.66	0.60	0.50	0.80	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	
10	35000.	4000.	0.	0.	0.	0.	0.	800.	4000.	0.	1500.	4000.	4800.	45300.	STACK
	0.60	0.60	0.50	0.80	0.60	0.50	0.60	0.80	0.80	0.80	0.60	0.0	0.0	0.0	

REFERENCE SIZE= 200000. CONVCOAL 1979

D-24

DRYASH ITEM	EQMT CGST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN L A B O R	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LAROP TOTAL	TOTAL COST	
1	49000. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	49000. 0.0	ASH SYLO
2	15500. 0.54	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	15500. 0.0	EJECTOR
3	51000. 0.46	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	51000. 0.0	SEPARATE
4	16300. 0.70	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	16300. 0.0	AIRWASHE
5	17000. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	17000. 0.0	VALVES/P
6	29000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	4500. 0.50	0. 0.60	800. 0.80	0. 0.80	0. 0.80	0. 0.60	4500. 0.0	800. 0.0	34300. 0.0	ASHTRASP
7	0. 0.0	10800. 0.60	7400. 0.50	0. 0.80	0. 0.60	5200. 0.50	5880. 0.60	16800. 0.80	47000. 0.80	4440. 0.80	12200. 0.60	29280. 0.0	68240. 0.0	109720. 0.0	DRYASHFO

TABLE D-2 (Continued)

Conventional Coal Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 200000. CONVCOL 1979

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WETASH ITEM	EQMT COST	MECH *****	STRUCT *****	INSTRUM *****	INSULAT *****	CIVIL *****	ELECTR *****	UNSKILL *****	MECHAN *****	ELECTR *****	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	10000. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	10000. 0.0	ASH CONV
2	11000. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	11000. 0.0	F ASH CO
3	17000. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	17000. 0.0	WATERPUM
4	3300. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	3300. 0.0	OVER "
5	3200. 0.41	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	3200. 0.0	ACID PUM
6	0. 0.0	3400. 0.60	0. 0.50	0. 0.80	0. 0.60	4500. 0.50	8640. 0.60	53000. 0.80	19000. 0.80	4320. 0.80	4500. 0.60	16540. 0.0	76320. 0.0	97360. 0.0	INST EQM
7	100000. 0.46	10000. 0.60	7000. 0.50	0. 0.80	3000. 0.60	2000. 0.50	1200. 0.60	8000. 0.80	28000. 0.80	2040. 0.80	3500. 0.60	23200. 0.0	38040. 0.0	164740. 0.0	SL. DEWAT
8	35000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.90	0. 0.60	0. 0.0	0. 0.0	35000. 0.0	SLDGERS
9	0. 0.46	40000. 0.60	0. 0.50	0. 0.80	0. 0.60	9000. 0.50	0. 0.60	13000. 0.80	14000. 0.80	0. 0.80	40000. 0.60	49000. 0.0	27000. 0.0	116000. 0.0	SFTL PDM

TABLE D-2 (Continued)

Conventional Coal Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 400000. PUL.COAL 1979

BOILER ITEM	EQMT COST	MECH *****	STRUCT *****	INSTRUM M A T E R I A L S *****	INSULAT *****	CIVIL *****	ELECTR *****	UNSKILL *****	MECHAN *****	ELECT? *****	RENTAL *****	MATERIAL *****	LABOR *****	TOTAL *****	
1	1705000. 0.60	69800. 0.60	26400. 0.50	0. 0.80	232500. 0.60	57400. 0.50	0. 0.60	209300. 0.80	713000. 0.60	0. 0.80	124000. 0.60	346100. 0.0	922300. 0.0	3137400. 0.0	TURBES, DR
2	93000. 0.60	13200. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	15000. 0.80	0. 0.80	1600. 0.60	17200. 0.0	15000. 0.0	122800. 0.0	SHIPWERS
3	17100. 0.0	5400. 0.60	0. 0.50	0. 0.80	1400. 0.60	0. 0.50	2200. 0.60	0. 0.80	6500. 0.80	900. 0.80	0. 0.0	9000. 0.0	7400. 0.0	33500. 0.0	OIL IGN.
4	542500. 0.60	58900. 0.60	0. 0.0	0. 0.80	17100. 0.60	7300. 0.50	14900. 0.60	7000. 0.80	79100. 0.80	8900. 0.80	5400. 0.60	98700. 0.0	95000. 0.0	741500. 0.0	PULV.FAN
5	93000. 0.0	15200. 0.60	0. 0.0	7800. 0.80	0. 0.0	3600. 0.50	4300. 0.60	0. 0.0	20200. 0.80	3500. 0.80	4700. 0.60	30900. 0.0	23700. 0.0	152300. 0.0	CL FDS
6	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	FUEL LIM
7	387500. 0.78	12400. 0.60	0. 0.0	0. 0.0	12400. 0.60	0. 0.0	0. 0.0	7800. 0.80	52700. 0.60	0. 0.0	20200. 0.60	24000. 0.0	60500. 0.0	493000. 0.0	SHIP HEAT
8	85300. 0.54	5100. 0.60	0. 0.0	0. 0.0	2500. 0.60	0. 0.0	4300. 0.60	3100. 0.80	10100. 0.80	3200. 0.80	0. 0.60	11900. 0.0	16400. 0.0	113600. 0.0	SOOT BL
9	77500. 0.66	12400. 0.60	0. 0.0	3900. 0.80	6200. 0.60	5600. 0.50	13000. 0.60	3100. 0.80	7800. 0.80	5600. 0.80	2900. 0.60	41100. 0.0	16500. 0.0	138000. 0.0	F.O.FAN
10	310000. 0.55	31000. 0.60	24800. 0.50	2800. 0.80	17100. 0.60	0. 0.0	4800. 0.60	0. 0.80	32600. 0.80	1500. 0.80	15500. 0.60	80500. 0.0	34100. 0.0	440100. 0.0	AIRHEAT
12	0. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	0. 0.0	S. STAKE

TABLE D-2 (Continued)

Conventional Coal Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 400000.

PUL.COAL

1979

MECHANIC															17
ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL + + +	MECHAN L A B O R	ELECTR + + +	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	65000. 0.47	7600. 0.60	0. 0.0	3000. 0.80	0. 0.0	0. 0.0	0. 0.0	0. 0.80	8600. 0.60	0. 0.0	2500. 0.60	10600. 0.0	8600. 0.0	96700. 0.0	DESUPER
2	175000. 0.50	26000. 0.60	14000. 0.50	15000. 0.80	25000. 0.60	6000. 0.50	9600. 0.60	24000. 0.80	65000. 0.80	7200. 0.80	10000. 0.60	95600. 0.0	96200. 0.0	376800. 0.0	SOFTNERS
3	135000. 0.60	29000. 0.60	0. 0.0	7000. 0.80	6200. 0.60	3400. 0.50	11400. 0.60	1800. 0.80	45000. 0.60	4800. 0.80	4000. 0.60	57000. 0.0	51600. 0.0	247600. 0.0	RLR PUMP
4	40000. 0.78	10000. 0.60	8000. 0.50	3700. 0.80	3500. 0.60	0. 0.0	0. 0.0	3400. 0.0	6500. 0.60	0. 0.0	2300. 0.60	26700. 0.0	2700. 0.0	76000. 0.0	FO W. HT
5	215000. 0.60	260000. 0.60	45000. 0.50	0. 0.80	90000. 0.60	0. 0.50	0. 0.60	4500. 0.80	130000. 0.80	0. 0.80	40000. 0.60	395000. 0.0	134500. 0.0	784500. 0.0	VALVES
6	50000. 0.55	2200. 0.60	4000. 0.50	0. 0.80	0. 0.60	800. 0.50	0. 0.60	1000. 0.80	4500. 0.80	0. 0.80	3500. 0.60	7000. 0.0	5500. 0.0	66000. 0.0	AIRPHTR
7	0. 0.0	15000. 0.60	0. 0.50	0. 0.80	0. 0.60	50000. 0.50	60000. 0.60	17000. 0.80	17000. 0.80	33600. 0.80	7000. 0.60	125000. 0.0	67600. 0.0	199600. 0.0	UTILS.
8	0. 0.0	8000. 0.60	140000. 0.50	0. 0.0	0. 0.60	26000. 0.50	44400. 0.60	28000. 0.80	45000. 0.80	24000. 0.80	30000. 0.60	218400. 0.0	97000. 0.0	345400. 0.0	BLGDSUPL

REFERENCE SIZE= 400000.

PUL.COAL

1979

INSTRUM															20
ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL + + +	MECHAN L A B O R	ELECTR + + +	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	UNDER AI
2	15000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	15000. 0.0	FEED CON

TABLE D-2 (Continued)

Conventional Coal Capital Cost Data and Scaling Exponents

3	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	OVER AIR
4	28000. 0.90	6000. 0.60	0. 0.50	0. 0.80	0. 0.60	1100. 0.50	1680. 0.60	0. 0.80	5300. 0.80	840. 0.80	0. 0.60	5780. 0.6	6140. 0.0	42920. 0.0	COMP AIR
5	10000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	10000. 0.0	CONT. PM
6	10000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	10000. 0.0	FUEL CON
7	50000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	50000. 0.0	CONR CON
8	110000. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	110000. 0.0	BURN MCM
9	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	OIL PAN
10	0. 0.0	20000. 0.60	0. 0.50	20000. 0.80	0. 0.60	0. 0.50	12000. 0.60	0. 0.80	100000. 0.80	48000. 0.80	0. 0.0	52000. 0.0	148000. 0.0	200000. 0.0	INSTPM I

REFERENCE SIZE= 400000. CONVCOAL 1979

FUELHAND ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM ***	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL ***	MECHAN ***	ELECTR ***	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	550000. 0.25	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	550000. 0.0	UNLOADIN
2	78000. 0.46	0. 0.0	0. 0.0	0. 0.0	0. 0.0	8000. 0.50	0. 0.0	6500. 0.80	0. 0.0	0. 0.0	0. 0.60	8000. 0.0	6500. 0.0	92500. 0.0	CHAL SIL
3	300000. 1.00	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.90	0. 0.60	0. 0.0	0. 0.0	300000. 0.0	RAIL SPW
4	100000. 1.00	0. 0.60	0. 0.50	0. 0.80	0. 0.60	50000. 0.50	0. 0.60	40000. 0.80	45000. 0.80	0. 0.80	25000. 0.60	50000. 0.0	85000. 0.0	260000. 0.0	DRAIN SY
5	100000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	100000. 0.0	THAWER

TABLE D-2 (Continued)

Conventional Coal Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 400000.

CONVCOAL

1979

FLUEGAS ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT ***	CIVIL ***	ELECTR ***	UNSKILL + + +	MECHAN L A B O R	ELECTR + + +	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	83000. 0.80	12000. 0.60	0. 0.50	0. 0.80	8500. 0.60	1500. 0.50	0. 0.60	4000. 0.80	15000. 0.80	0. 0.80	1500. 0.60	22000. 0.0	19000. 0.0	125500. 0.0	DUST COL
2	495000. 0.80	118000. 0.60	78400. 0.50	60000. 0.80	126000. 0.60	10000. 0.50	45600. 0.60	55000. 0.80	175000. 0.80	36000. 0.80	35000. 0.60	438000. 0.0	266000. 0.0	1234000. 0.0	BAGHOUSE
3	262000. 0.62	158000. 0.60	80000. 0.50	80000. 0.80	235000. 0.60	8400. 0.50	108000. 0.60	45000. 0.80	150000. 0.80	55200. 0.80	13000. 0.60	569400. 0.0	250200. 0.0	1194600. 0.0	ELEC PRE
4	465000. 0.56	60000. 0.60	50000. 0.50	20000. 0.80	42000. 0.60	28000. 0.50	26400. 0.60	80000. 0.80	155000. 0.80	32400. 0.80	29000. 0.60	226400. 0.0	267600. 0.0	987800. 0.0	WETFLUGA
5	1000000. 0.64	170000. 0.60	80000. 0.50	20000. 0.80	67000. 0.60	13000. 0.50	10800. 0.60	66000. 0.80	103000. 0.80	13200. 0.80	56000. 0.60	360800. 0.0	182200. 0.0	1599000. 0.0	DRYFLUGA
6	20000. 0.60	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	20000. 0.0	LIME CRU
7	50000. 0.46	23000. 0.60	9000. 0.50	4000. 0.80	0. 0.60	5000. 0.50	5400. 0.60	7500. 0.80	17000. 0.80	3600. 0.80	3500. 0.60	46400. 0.0	28100. 0.0	128000. 0.0	LIME SIL
8	18000. 0.66	1800. 0.60	0. 0.50	0. 0.80	0. 0.60	1000. 0.50	2280. 0.60	0. 0.80	6000. 0.80	1560. 0.80	700. 0.60	5080. 0.0	7560. 0.0	31340. 0.0	LIME TAN
9	100000. 0.66	17000. 0.60	0. 0.50	2400. 0.80	7000. 0.60	5000. 0.50	21600. 0.60	2800. 0.80	20000. 0.80	14400. 0.80	2500. 0.60	53000. 0.0	37200. 0.0	192700. 0.0	I.O.FAN/
10	80000. 0.60	7000. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	1500. 0.80	7000. 0.80	0. 0.80	2000. 0.60	7000. 0.0	8500. 0.0	97500. 0.0	STACK

TABLE D-2 (Continued)

Conventional Coal Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 400000. CONVCOAL 1979

DRYASH ITEM	EQMT COST	MECH *****	STRUCT *****	INSTRUM *****	INSULAT *****	CIVIL *****	ELECTR *****	UNSKILL *****	MECHAN *****	ELECTR *****	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	98000. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	98000. 0.0	ASH SILO
2	30000. 0.54	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	30000. 0.0	EJECTOR
3	100000. 0.46	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	100000. 0.0	SEPARATOR
4	32000. 0.70	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	32000. 0.0	AIR WASH
5	34000. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	34000. 0.0	VALVES/P
6	60000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	7000. 0.50	0. 0.60	1500. 0.80	0. 0.80	0. 0.80	0. 0.60	7000. 0.0	1500. 0.0	68500. 0.0	ASH TRAN
7	0. 0.0	21000. 0.60	14500. 0.50	0. 0.80	0. 0.60	10400. 0.50	11760. 0.60	33000. 0.80	94000. 0.80	8880. 0.80	24400. 0.60	57660. 0.0	135880. 0.0	217940. 0.0	ASH EQUI

D-30

TABLE D-2 (Concluded)

Conventional Coal Capital Cost Data and Scaling Exponents

REFERENCE SIZE= 400000. CONVCOAL 1979

WETASH ITEM	EQMT COST	MECH ***	STRUCT ***	INSTRUM M A T E R I A L S	INSULAT L S	CIVIL ***	ELECTR ***	UNSKILL + + +	MECHAN L A B O R	ELECTR + + +	RENTAL COST	MATERIAL TOTAL	LABOR TOTAL	TOTAL COST	
1	19000. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	19000. 0.0	R ASHCON
2	20000. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	20000. 0.0	W ASHCON
3	32000. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	32000. 0.0	WAT PUMP
4	6600. 0.60	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	6600. 0.0	OVER "
5	6400. 0.41	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	0. 0.0	6400. 0.0	ACID "
6	0. 0.0	6700. 0.60	0. 0.50	0. 0.80	0. 0.60	9000. 0.50	16800. 0.60	106000. 0.80	38000. 0.80	8640. 0.80	9000. 0.60	32500. 0.0	152640. 0.0	194140. 0.0	WET A IN
7	150000. 0.46	15000. 0.60	10000. 0.50	0. 0.80	4200. 0.60	2900. 0.50	1920. 0.60	13000. 0.80	46000. 0.80	3960. 0.80	5500. 0.60	34120. 0.0	62960. 0.0	252480. 0.0	SI. DEWAT
8	70000. 0.0	0. 0.60	0. 0.50	0. 0.80	0. 0.60	0. 0.50	0. 0.60	0. 0.80	0. 0.80	0. 0.80	0. 0.60	0. 0.0	0. 0.0	70000. 0.0	SLOGETRA
9	0. 0.46	65000. 0.60	0. 0.50	0. 0.80	0. 0.60	15000. 0.50	0. 0.60	20000. 0.80	20000. 0.80	0. 0.80	60000. 0.60	80000. 0.0	40000. 0.0	180000. 0.0	SETL PDM

APPENDIX E
RECORD FORMATS OF COSTEAM FILES

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DATA FILES

The COSTEAM model requires eight input/output files, only five of which are data files. The remaining three are used to access the user terminal and the high-speed printer. A summary description of all files was given in Table 3-5. In this section detailed description of the data file formats are presented to assist system programmers in maintenance or expanding the files. The COSTEAM model only reads these data files. No calculations or overrides are permanently stored.

E.1 GLOBAL FILE

The global file contains data that is independent of steam generation technology. Namely, these data are lists of parameter names, parameter storage indices and parameter data values. The system programmer can use the system editor to change parameter values. The parameter names may be changed also, but this will require modification of the User Guide to reflect the new names and may require modification of the report file. The storage indices should not be changed unless corresponding changes are made in the program coding. Parameter additions or deletions may also require coding changes.

Table E-1 gives the general structure of the global file. Tables E-2 through E-9 give the detailed record formats. The global file contains three types of individual record formats given in Tables E-13 through E-19.

E.2 SYSTEM FILE

The system file contains data for each steam generation technology. Namely, these data are lists of parameter names, parameter storage indices and parameter values. The parameters in the system

TABLE E-1

GLOBAL FILE GENERAL STRUCTURE

<u>RECORD TYPE</u>	<u>GENERAL DESCRIPTION</u>	<u>NUMBER OF OCCURANCES</u>	<u>FORMAT TABLE</u>
1	Miscellaneous constants	One	Table A-2
2	Region names	Depends of record type 1	Table A-3
3	Years	Depends on record type 1	Table A-4
4	Simple parameters	Given in record type 1	Table A-5
5	Parameter group header	Given in record type 1	Table A-6
6	Parameters within parameter group	Given in record type 5 (following each type 5 record are several type 5 records)	Table A-7
7	Parameter vector header	Given in record type 1	Table A-8
8	Parameter vector	Depends on record type 7 (following each type 7 record are several type 8 records)	Table A-9

TABLE E-2

GLOBAL FILE

RECORD TYPE 1 FORMAT
MISCELLANEOUS CONSTANTS

<u>Columns</u>	<u>Description</u>
1-5	Number of regions
6-10	Number of years
11-15	Number of simple parameters
16-20	Number of parameter groups
21-25	Number of parameter vectors

TABLE E-3
GLOBAL FILE
RECORD TYPE 2 FORMAT
REGION NAMES

<u>Columns</u>	<u>Description</u>
1-8	} Region names
11-18	
21-28	
31-38	
41-48	
51 58	
61-68	

This record is repeated the number of times required to name all regions.

TABLE E-4

GLOBAL FILE

RECORD TYPE 3 FORMAT
YEARS

<u>Columns</u>	<u>Description</u>
5-8	} Years in ascending order
15-18	
25-28	
35-38	
45-48	
55-58	
65-68	

This record is repeated the number of times required to list all years.

TABLE E-5
GLOBAL DATA FILE
RECORD TYPE 4
SIMPLE PARAMETERS

<u>Columns</u>	<u>Description</u>
1-8	Parameter name
9-12	Storage index
13-22	Data value

There is one record for each simple parameter.

TABLE E-6

GLOBAL DATA FILE

RECORD TYPE 5
PARAMETER GROUP HEADER

<u>Columns</u>	<u>Description</u>
1-8	Parameter group name
9-12	Group storage index
13-15	Number of parameters in the group. (Number of type 5 records that immediately follow this type 5 record)

There is one parameter group header record for each parameter group.
Following each header record are several type 6 parameter records.

TABLE E-7
GLOBAL DATA FILE
RECORD TYPE 6
PARAMETERS WITHIN PARAMETER GROUP

<u>Columns</u>	<u>Description</u>
1-8	Parameter name
9-12	Storage index
13-22	Data value

There is one record for each parameter in the group.

TABLE E-8
GLOBAL DATA FILE
RECORD TYPE 7
PARAMETER VECTOR HEADER

<u>Columns</u>	<u>Description</u>
1-8	Vector name
9-12	Vector storage index
13-15	Number of elements in the vector. (Determine the number of type 8 records that immediately follow this type 7 record)

There is one parameter vector header for each parameter vector.
Following each header record are several type 8 records.

TABLE E-9
GLOBAL DATA FILE
RECORD TYPE 8
PARAMETER VECTOR

<u>Columns</u>	<u>Description</u>
1-10	} Vector elements
11-20	
21-30	
31-40	
41-50	
51-60	
61-70	

This record is repeated the number of times required to contain all elements in the vector.

TABLE E-10

SYSTEM FILE GENERAL STRUCTURE

RECORD GROUP	GENERAL DESCRIPTION	NUMBER OF OCCURENCES	SUBSTRUCTURE TABLE
1	System level record group	1	Table E-11
2	Component level record groups	Depends on number of components & variants given in record group 1.	Table E-12

After each type one record group are several type 2 record groups. There is one type 2 group for each component and for each variant of each component. All variants of a component are given before proceeding to the next component.

TABLE E-11

SYSTEM FILE

SYSTEM LEVEL RECORD GROUP STRUCTURE

RECORD TYPE	GENERAL DESCRIPTION	NUMBER OF OCCURENCES	FORMAT TABLE
1	System (technology) header	1	Table E-13
2	System level input parameter	Depends on record type 1	Table E-14
3	System level output parameter	Depends on record type 1	Table E-15
4	Variant definitions	Given in record type 1	Table E-16
5	Report names	Given in record type 1	Table E-17

This record group structure occurs once for each technology. Immediately after each occurrence are the component level record groups for each variant of each component.

TABLE E-12

SYSTEM FILE

COMPONENT LEVEL RECORD GROUP STRUCTURE

RECORD TYPE	GENERAL DESCRIPTION	NUMBER OF OCCURENCES	FORMAT TABLE
6	Component header	1	Table E-18
7	Component level input parameters	Depends on record type 6	Table E-14
8	Component level output parameters	Depends on record type 6	Table E-15
9	Table names	Given in record type 6	Table E-19

This record group structure is repeated for each variant of each component of the given system (technology). The components should occur in the order in which they will be processed by the submodel program.

TABLE E-13

SYSTEM FILE

RECORD TYPE 1 FORMAT
SYSTEM HEADER

COLUMNS	DESCRIPTION
1 - 8	System name
11 - 15	Number of system level input parameters
16 - 20	Number of system level output parameters
21 - 25	Number of variants
26 - 30	Number of reports
31 - 35	Number of components (not including component variants)

TABLE E-14

SYSTEM FILE

RECORD TYPES 2 AND 7 FORMATS
INPUT PARAMETERS

COLUMNS	DESCRIPTION
1 - 8	First parameter name
9 - 12	First parameter storage index
13 - 22	First parameter value
23	First parameter user override indicator (blank for override permitted, "*" for override not permitted)
24 - 31	Second parameter name
32 - 35	Second parameter storage index
36 - 45	Second parameter value
46	Second parameter user override indicator
47 - 54	Third parameter name
55 - 58	Third parameter storage index
59 - 68	Third parameter value
70	Third parameter user override indicator

This record is repeated the number of times required to define all input parameters.

TABLE E-15

SYSTEM FILE

RECORD TYPES 3 AND 8 FORMATS
OUTPUT PARAMETERS

COLUMNS	DESCRIPTION
1 - 8	First parameter name
9 - 12	First parameter storage index
13	First parameter user override indicator (blank for override permitted, "*" for override not permitted)
14 - 21	Second parameter name
22 - 25	Second parameter storage index
26	Second parameter user override indicator
27 - 34	Third parameter name
35 - 38	Third parameter storage index
39	Third parameter user override indicator
40 - 47	Fourth parameter name
48 - 51	Fourth parameter storage index
52	Fourth parameter user override indicator
53 - 60	Fifth parameter name
61 - 64	Fifth parameter storage index
65	Fifth parameter user override indicator

This record is repeated the number of times required to define all output parameters.

TABLE E-16

SYSTEM FILE

RECORD TYPE 4 FORMAT
VARIANT DEFINITIONS

COLUMNS	DESCRIPTION
1 - 8	Variant name
10 - 12	First component sequence number for this variant (components that are the same for all variants will have a sequence number "1". A sequence number of "0" means that the component is omitted for this variant.
13 - 14	Second component sequence number for this variant.
15 - 16	Third component sequence number for this variant.
↓ ↓	
59 - 60	Twenty-fifth component sequence number for this variant.

There is one record for each variant.

TABLE E-17

SYSTEM FILE

RECORD TYPE 5 FORMAT
REPORT NAMES

COLUMNS	DESCRIPTION
1 - 8	Report name used for communication with the user
10 - 17	Actual name of report in the report file

There is one record for each report. The records should be placed in the order in which the reports will be printed.

TABLE E-18

SYSTEM FILE

RECORD TYPE 6 FORMAT
COMPONENT HEADER

<u>Columns</u>	<u>Description</u>
1-8	Component names
9	Sequence number (used to identify component variants. If there are no variants of a component, the sequence number is "1")
11-15	Number of input parameters for the component
16-20	Number of output parameters for the component
21-25	Number of tables for the component

TABLE E-19

SYSTEM FILE

RECORD TYPE 9 FORMAT TABLE NAMES

COLUMNS	DESCRIPTION
1 - 8	Table name known by the submodel program
10 - 17	Actual name of table in the table file

There is one record for each table required by the components. The records should be placed in the order in which the submodel program will require them.

file are simple parameters much like those in the global file. They are classified as belonging either to the system as a whole (system level parameter) or to one of a number of system components (component parameters). Furthermore, each parameter is either an input parameter with its data value given in the file or an output parameter that has its value calculated by the submodel program. It would be possible for a submodel to change an input value but this change would not be reflected in the system file.

Storage indices for each technology are independent and thus should begin within the index "1". However, within a technology storage, indices must not overlap among the system level and the various component level parameters.

The changing of parameter names, storage indices and data values in the system file requires the same considerations as changes in the global file. Parameter values may be changed as desired, whereas changing parameter names and storage indices requires corresponding changes in the User Guide, the report file and the program coding.

The system file contains references to tabular data and functions in the table file. Thus, all data unique to a technology are found in both the system and the table files. It would be possible to have system dependent data in the global file but this is not recommended.

The system file structure is made more complicated by the existence of technology variants. For example, the stoker and pulverized coal

variants of the conventional coal boiler have different input parameter values and tables for some of the system components. System level parameter names and storage indices are the same for all variants of a technology. Variants exist on the system file as duplications of all records for certain components. The only data items that may differ in these duplicate records are the input parameter values and table names.

Table E-10 gives the general structure of the system file. This structure is repeated for each technology contained in the file. Because the system file structure is somewhat complicated, Table E-10 is confined to record groupings and Tables E-11 and E-12 give the actual substructure of each record group. The parameters--simple, group, and vector. Storage indices of all parameters within a parameter group are independent of storage indices of parameters within the other groups. Thus parameters within each group may also begin with the index "1".

Simple parameters may be used for various miscellaneous constants. Parameter groups are used to define fuel characteristics and environmental standards. Parameter vectors are used to define time or region variant data. Therefore, the number of elements in a vector equals either the number of years or the number of regions. The use of parameter groups and vectors is not restricted to these conventions and may be extended with appropriate program coding modifications.

E.3 REPORT FILE

The report file contains report specification data for all steam generation technologies. Each report is described by a list of parameter names and a list of identifying labels. The file does not contain parameter storage indices because these can be found on the global and the system files. The report file can be modified to reformat existing reports or to add and delete reports. However, changes, additions or deletions made to the report names must also be made to report references in the system file. (See Table E-17.)

In order to reduce program execution time, the reports are placed in the file in the order in which they will be used. This means that all reports for a given technology are grouped together and ordered according to their reference in the system file. (See Table E-17.) It is also best to have reports ordered by increasing complexity of detail since this is the most logical way for users to request their printout.

Table E-20 gives the general structure of the report file. Tables E-21 through E-25 give the detailed record formats. Each report consists of a number of sections. Each section may contain either a single parameter, a single column of parameters, or a two dimensional tabular array consisting of rows and columns of parameters. Rows and columns may be totaled if desired. When a report is printed, rows that have zero totals will be omitted whether or not a row total was requested. If a section consists of a single column, the printout of zero elements is suppressed.

TABLE E-20

REPORT FILE GENERAL STRUCTURE

RECORD TYPE	GENERAL DESCRIPTION	NUMBER OF OCCURENCES	FORMAT TABLE
1	Report header	1	Table E-21
2	Report title	3	Table E-22
3	Section header	Given in record type 1	Table E-23
4	Section report para- meters	Depends on record type 3 (Following each type 3 record are several type 4 records.)	Table E-24
5	Section labels	Depends on record type 3 (Following all type 4 records are several type 5 records.)	Table E-24

Record types 3, 4, and 5 comprise a report section. They are repeated as a group until all report sections have been specified.

The entire structure given above occurs once for each report.

TABLE E-21

REPORT FILE

RECORD TYPE 1 FORMAT
REPORT HEADER

COLUMNS	DESCRIPTION
1 - 8	Report name
11 - 15	Number of sections in the report

TABLE E-22

REPORT FILE

RECORD TYPE 2 FORMAT
REPORT TITLE

COLUMNS	DESCRIPTION
1 - 72	One line in the report title

This record occurs three times.

TABLE E-23

REPORT FILE

RECORD TYPE 3 FORMAT
SECTION HEADER

COLUMNS	DESCRIPTION
1 - 2	Number of rows in the section
3	Row total indicator (T = print row totals)
5 - 6	Number of columns in the section
7	Column total indicator (T = print column totals)
9 - 11	Number of type 4 records that follow (If blank, the number of type 4 records is calculated from the number of rows and columns by assuming 4 parameters per record.)
21 - 60	Section title

TABLE E-24

REPORT FILES

RECORD TYPE 4 FORMAT
SECTION REPORT PARAMETERS

COLUMNS	DESCRIPTION
1 - 8	Name of group to which the first parameter belongs (system name, component name, "GLOBAL", "MODEL", "FUEL", "ENVIRON")
9 - 16	First parameter name
18 - 25	Name of group to which second parameter belongs
26 - 33	Second parameter name
35 - 42	Name of group to which third parameter belongs
43 - 50	Third parameter name
52 - 59	Name of group to which fourth parameter belongs
60 - 67	Fourth parameter name

This record is repeated the number of times required to define all report parameters in the section. The parameters are listed in column order. (i.e., an entire column of parameters is given as a contiguous list.)

TABLE E-25

REPORT FILE

RECORD TYPE 5 FORMAT
SECTION LABELS

COLUMNS	DESCRIPTION
1 - 19	Line one of a label
20 - 38	Line two of a label

This record is repeated the number of times required to define all labels. There is one label for each column and one for each row. Column labels are given first. If there is only one parameter in the report, only one label may be given. This will be a row label.

E.4 TABLE FILE

The table file contains tabular data and function constants for all technologies. The data in the file may be changed, but if the table name is changed, the table references in the system file must also be changed. (See Table E-19.)

There are two types of tables that can be placed in the table file. The first type is a conventional table consisting of one dependent variable and up to three independent variables. The second type is a list of constants (B and E) used to evaluate the scaling function $Y = BX^E$. Each set of constants is identified by a function index that is keyed to the technology submodel program. Typically, type two tables are used to scale component capital costs and the function index is used to specify the component, equipment item, and cost type. If function indices are changed, corresponding changes must be made in the program coding.

Each table is keyed to a specific year that must be equal to or less than the current year. (The current year is the last year in the year list on the global file. See Table E-4.) Yearly price indices contained in a global file parameter vector can be used by the program to update the table to the current year if the vector name is specified on the table file.

Table E-26 gives the general structure of the table file. Tables E-27 through E-29 give the detailed record formats. In order to reduce program execution time, all tables are placed in the file

TABLE E-26

TABLE FILE GENERAL STRUCTURE

RECORD TYPE	GENERAL DESCRIPTION	NUMBER OF OCCURENCES	FORMAT TABLE
1	Table header	1	Table E-27
2a	Type one table	Given in record type 1	Table E-28
2b	Type two table	Given in record type 2	Table E-29

This structure occurs for each table. An individual table will contain either type 2a records or 2b records but not both.

TABLE E-27

TABLE FILE

RECORD TYPE 1 FORMAT
TABLE HEADER

COLUMNS	DESCRIPTION
1 - 8	Table name
9	Table type (1 = conventional table) (2 = function constants)
11 - 15	Number of table entries
16 - 23	Name of global parameter vector used to update table to current year. (May be omitted.)
24 - 28	Year to which table applies

TABLE E-28

TABLE FILE

RECORD TYPE 2A FORMAT
TYPE ONE TABLE

COLUMNS	DESCRIPTION
1 - 10	Dependent variable value
11 - 20	Independent variable No. 1 value
21 - 30	Independent variable No. 2 value
31 - 40	Independent variable No. 3 value

There is one record for each table entry.

TABLE E-29

TABLE FILE

RECORD TYPE 2B FORMAT
TYPE TWO TABLE

COLUMNS	DESCRIPTION
1 - 10	Function index
11 - 20	Function constant B (scale factor)
21 - 30	Function constant E (exponent)

There is one record for each table entry.

in the order in which they will be used. This means that all tables for a given technology are grouped together and ordered according to their reference in the system file (Table E-19).

E.5 ERROR MESSAGE FILE

The error message file contains the error messages to be printed whenever the submodel program detects an exceptional parameter value or operating condition. The exact wording of the message may be changed, but if error numbers are changed, corresponding changes must be made in the submodel program.

Table E-30 gives the general structure of the error message file. Tables E-31 and E-32 give the detailed record formats. All error messages for a system (technology) are grouped together.

TABLE E-30
ERROR MESSAGE FILE GENERAL STRUCTURE

RECORD TYPE	GENERAL DESCRIPTION	NUMBER OF OCCURENCES	FORMAT TABLE
1	Error header	1	Table E-31
2	Error message	Given in record type 1	Table E-32

TABLE E-31

ERROR MESSAGE FILE

RECORD TYPE 1 FORMAT
ERROR HEADER

COLUMNS	DESCRIPTION
1 - 8	System name
11 - 15	Error number
16 - 20	Number of error message lines

TABLE E-32

ERROR MESSAGE FILE

RECORD TYPE 2 FORMAT
ERROR MESSAGE

COLUMNS	DESCRIPTION
1 - 72	Error message

There is one record for each error message line.

APPENDIX F
COSTEAM FILES

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Table F-1 lists the COSTEAM FORTRAN source code files and data files. The FORTRAN source code is written on nine files named X FORTRAN where X takes on values A-G, GAFFB, GOIL, and I. Table F-2 lists the file on which each COSTEAM subroutine is stored. Figure F-1 lists the IBM Conversational Monitor System (CMS) EXEC file for running COSTEAM.

The system data file contains parameter names, storage indices and default values for the AFBCOAL, CONVCOAL, and CONVOIL systems in that order. For each system, the system data file also contains the names of reports and tables used for that technology.

Table F-3 lists the names of the reports stored on report data file and the technologies for which these report specifications are used. The report specifications are listed in Table F-3 in the order in which they appear on the report data file.

Table F-4 lists the names of the tables on the Table Data file. The three steam tables are used by all technologies.

TABLE F-1
COSTEAM SOURCE FILES

FILE NAME	FILE TYPE	RECORD LENGTH	NUMBER OF RECORDS
A	FORTTRAN	80	420
B	FORTTRAN	80	687
C	FORTTRAN	80	507
D	FORTTRAN	80	262
E	FORTTRAN	80	1000
F	FORTTRAN	80	317
G	FORTTRAN	80	1724
GAFB	FORTTRAN	80	1664
GOIL	FORTTRAN	80	1722
I	FORTTRAN	80	572
ERROR	DATA	80	100
GLOBAL	DATA	80	239
REPORT	DATA	80	3450
SYSTEM	DATA	80	1430
TABLE	DATA	40	4675

TABLE F-2

COSTEAM FORTRAN SOURCE CODE*

SUBROUTINE NAME	SOURCE FILE	SUBROUTINE NAME	SOURCE FILE
AFBC	GAFB	PRINT	E
COLTIT	E	PRINTP	E
CNCOAL	G	PROW	E
CNOIL	GOIL	PSEARC	E
ERATIT	F	READB	B
ERAROW	F	READC	C
ERR	D	READG	C
E215	B	READP	C
		READR	C
FINANC	B	READRD	E
FORMAT	E	READS	C
G2CHNG	D	READT	C
GCHANG	D	READV	C
IA	I	REPERA	F
IC	I	REPORG	E
INFLAT	B	REPORU	E
IO	I	RTAB	B
OVER	B	TAB	B
PAGE	E	TREADN	B
PERR	D	ZERO	D
PRICE	B		

* THE MAIN PROGRAM IS ON FORTRAN SOURCE FILE A.

FIGURE F-1

EXEC FILE FOR RUNNING COSTEAM

&CONTROL ERROR
SET BLIP OFF
GLOBAL TXTLIB FORTMOD1
TERMINAL LINES 120
FI 1 DISK GLOBAL DATA A (RECFM F LRECL 80 BLKSIZE 800
FI 2 DISK SYSTEM DATA A (RECFM F LRECL 80 BLKSIZE 3200
FI 3 DISK REPORT DATA A (RECFM F LRECL 80 BLKSIZE 3200
FI 4 TERMINAL (RECFM FB LRECL 120 BLKSIZE 120
FI 5 TERMINAL
FI 6 PRINTER
FI 7 DISK TABLE DATA A (RECFM FB LRECL 40 BLKSIZE 3200
FI 8 DISK ERROR DATA A (RECFM FB LRECL 80 BLKSIZE 3200
LOAD A B C D E F G GAFB GOIL I (NOMAP
SPOOL CONSOLE START
START

TABLE F-3
REPORT DATA FILE

NAME OF REPORT SPECIFICATIONS	TECHNOLOGY USING THESE SPECIFICATIONS
SUMMARY	CONVCOAL
OSUMMARY	CONVOIL
ERA	CONVCOAL
SUMCAP	CONVCOAL, CONVOIL
CAPITAL	CONVCOAL, CONVOIL
DESIGN	CONVCOAL
OPERATE	CONVCOAL
ODESIGN	CONVOIL
OOPERATE	CONVOIL
FINANCE	CONVCOAL, CONVOIL
MATERIAL	CONVCOAL, CONVOIL
ASUMMARY	AFBCOAL
AERA	AFBCOAL
ASUMCAP	AFBCOAL
ACAPITAL	AFBCOAL
ADESIGN	AFBCOAL
AOPERATE	AFBCOAL
AFINANCE	AFBCOAL
AMATERIA	AFBCOAL
AERA	CONVOIL

TABLE F-4

NAMES OF TABLES ON TABLE DATA FILE

<u>STEAM TABLES</u>		
TEMPERAT	(T vs P for saturated steam)	
ENTHALPY	(H vs P for saturated steam)	
SUPERHEA	(H vs Panel T for superheated steam)	

<u>CAPITAL COSTS AND SCALING EXPONENTS</u>		
<u>CONVENTIONAL</u> <u>COAL</u>	<u>ATMOSPHERIC</u> <u>FLUIDIZED BED</u>	<u>CONVENTIONAL</u> <u>OIL**</u>
CAP01A1*	AFB01A1	
CAP01A2	AFB01A2	OIL01A
CAP02A1	AFB02A	OIL02A
CAP02A2	AFB03A	OIL03A
CAP03A1	AFB04A	OIL04A
CAP03A2	AFB05A	OIL01B
CAP04A	AFB06A	OIL02B
CAP05A	AFB08A1	OIL03B
CAP06A	AFB08A2	OIL04B
CAP07A	AFB09A	OIL01C
CAP01B2	AFB01B1	OIL02C
CAP02B2	AFB01B2	OIL03C
CAP03B2	AFB02B	OIL04C
CAP04B	AFB03B	
CAP05B	AFB04B	
CAP06B	AFB05B	
CAP07B	AFB06B	
CAP01C2	AFB08B1	
CAP02C2	AFB08B2	
CAP03C2	AFB09B	
CAP04C	AFB01C1	
CAP05C	AFB01C2	
CAP06C	AFB02C	
CAP07C	AFB03C	
	AFB04C	
	AFB05C	
	AFB06C	
	AFB08C1	
	AFB08C2	
	AFB09C	

* The digits 01-09 designate the plant component. The last letter (A,B, or C) indicates 100,000, 200,000, or 400,000 pounds of steam per hour. The last digit on conventional coal boiler table names indicates stoker (1) or pulverized coal (2). The last digit on AFB table names indicates vendor (1) or theory (2) variant.

** Oil-fired boiler components 5, 6 and 7 use conventional coal tables.

Department Approval: Douglas M. Medville

MITRE Project Approval: Douglas M. Medville

U.S. DEPARTMENT OF ENERGY

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4. Title COSTEAM Expansion and Improvement Design of a Coal-Fired Atmospheric Fluidized Bed Submodel and Input/Output Improvements

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