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ORNL/TM-8146

MASTER

**User's Manual for the INDCEPT
Code for Estimating Industrial
Steam/Boiler/Plant Capital
Investment Costs**

H. I. Bowers

L. C. Fuller

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Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road, Springfield, Virginia 22161
NTIS price codes—Printed Copy: A05; Microfiche A01

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ORNL/TM--8146

ORNL/TM-8146

DE82 021111

Contract No. W-7405-eng-26

MASTER

Engineering Technology Division

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STEAM-BOILER-PLANT CAPITAL-INVESTMENT COSTS**

**H. I. Bowers L. C. Fuller
C. R. Hudson II**

Date Published - September 1982

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ACKNOWLEDGMENTS

The development of the INDCEPT computer code was sponsored by the Morgantown Energy Technology Center, U.S. Department of Energy.

The authors acknowledge the technical assistance of J. G. Delene and B. H. Fitzgerald in the development of the cost-model data sets.

USER'S MANUAL FOR THE INDCEPT CODE FOR ESTIMATING INDUSTRIAL STEAM BOILER PLANT CAPITAL INVESTMENT COSTS

H. I. Bowers L. C. Fuller
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ABSTRACT

The INDCEPT computer code package was developed to provide conceptual capital investment cost estimates for single- and multiple-unit industrial steam boiler plants. Cost estimates can be made as a function of boiler type, size, location, and date of initial operation. The output includes a detailed breakdown of the estimate into direct and indirect costs.

Boiler plant cost models are provided to reflect various types and sources of coal and alternate means of sulfur and particulate removal. Cost models are also included for low-Btu and medium-Btu coal-gasification plants.

Keywords: capital investment costs, industrial boiler coal-gasification.

1. INTRODUCTION

Three computer programs, which are referred to as the INDCEPT package, have been developed by the Engineering Technology Division of the Oak Ridge National Laboratory (ORNL). This computer package is designed to provide a rapid means of estimating future capital investment costs of different types of industrial boilers under various sets of economic and technical ground rules. The use of the INDCEPT code requires an understanding of trends in contributing cost factors, such as labor rates, labor productivity, and materials and equipment prices, as a function of location and time. For application in project evaluation studies, these cost factors should be based on the specific location and design and construction dates being considered. Cost estimates produced by the INDCEPT code are not intended as substitutes for detailed cost estimates for specific projects; however, the INDCEPT estimates should be useful for preliminary studies.

The INDCEPT package represents a spin-off of the CONCEPT-5 computer code used for estimating the capital investment costs of nuclear-fueled and fossil-fired steam electric power plants. Although the programs are not identical, the basic program flows and methodology are similar. As a result, readers desiring a more detailed description of the methodology and the program subroutines should consult the CONCEPT-5 User's Manual.¹

The INDCEPT package consists of three separate computer programs as illustrated in Fig. 1.1. At the preoperational level the INDTAC auxiliary program, described in Appendix A, is used to read cost-model data (i.e.,

Fig. 1.1. INDCEPT package.

detailed cost breakdowns for reference plants) for the various types of plants and to generate the cost-model data file, COMO, on a magnetic storage device. The CONLAM auxiliary program, described in Appendix B, is used to read historical cost data for factory equipment, labor, and site-related materials at various locations and to generate the data file, LAMA, on a second magnetic storage device. The two auxiliary programs, INDTAC and CONLAM, are important parts of the total INDCEPT package and must be used to generate, update, and modify the data files. The main body of this report is devoted to the operational level INDCEPT program, which retrieves cost-model data and historical cost data from the two previously prepared data files and uses them to generate cost estimates based on the ground rules specified by the user at program execution time.

The three programs are written for batch processing in FORTRAN IV for the IBM 360, 370, and 3033 machines. Less than 270K (bytes) of computer core are required for any one of the three programs. Computer time required for a single cost calculation is dependent on the complexity of the case but averages only a few seconds.

The INDCEPT package, including auxiliary programs and cost-model and historical cost data sets, can be obtained only from the National Energy Software Center, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois 60439.

2. GENERAL DESCRIPTION OF THE INDCEPT CODE

The procedures used in the INDCEPT code are based on the assumption that any industrial boiler plant using similar fuel and having similar environmental controls involves approximately the same major cost components, regardless of location or date of initial operation. Therefore, if the trends of these major cost components can be established as a function of time, location, and boiler size, a cost estimate for a reference case can be adjusted to fit any case of interest.

The application of this approach requires a detailed cost model for each plant type at a reference condition and the determination of the cost trend relationships. The generation of these data sets comprises a large effort in the development of the code.

The cost model for each type of plant is based on a detailed cost estimate for a reference plant at a designated time and location. Each estimate includes a breakdown of each cost account into costs for equipment, labor, and site-related materials. The cost models are stored on a magnetic storage device (the COMO data file) by the auxiliary program, INDTAC, which is described in Appendix A.

Data that reflect historical trends in equipment costs, labor rates, and prices of site-related materials for 23 locations are stored on a second magnetic storage device (the LAMA data file) by the auxiliary program, CONLAM, which is described in Appendix B. INDCEPT uses the historical equipment, labor, and materials cost data to calculate cost indices for translating the cost-model data from the reference time and location to the specified time and location.

The input to INDCEPT consists of the unit size in MBtu/h, plant model name, plant location, date of major equipment purchase (i.e., boiler or gasifier), date of the start of construction, date of initial commercial operation, interest rate, and number of units in the plant. Specific constants, variables, and cost arrays, which are listed in Chap. 5 of this report, can be altered by input option. In addition, the escalation rates calculated by the code from data stored in the historical cost data file (LAMA file) can be overridden by input option. Contingency cases can be examined with a minimum of effort, and the cost-model data can be altered

temporarily at execution time to take into account known costs or factors that affect the design of the plant.

The technique of separating the plant cost into individual components, applying appropriate cost indices, and summing the adjusted components is the basic tool used in INDCEPT. A schematic illustration of this technique is presented in Fig. 2.1. Three sets of cost indices as functions of time and location are required. These indices are used to adjust the costs of equipment, labor, and site-related materials. The equipment cost indices are calculated from Bureau of Labor Statistics data. The labor cost indices are calculated from basic parameters, which include wage rates for the various crafts, labor productivity, and overtime considerations. The materials cost indices are calculated from unit costs for site-related materials, which include structural steel, reinforcing steel, concrete, and lumber. A detailed breakdown of the equipment, labor, and materials categories is included in Appendix B.

Figure 2.2 indicates the general flow of calculations in INDCEPT. The computer code follows this procedure closely; however, the illustration is not a detailed computer program flowchart.

Fig. 2.1. Method used to adjust reference costs in INDCEPT.

Fig. 2.2. General flow of calculations in INDCEPT.

Block 1 refers to the input data stream. This input is read from punched cards and, for each case, must include the net unit size, the plant model name, plant location (one of 23 cities), design and construction period, and number of units in the plant (1 through 4). The code will make the following assumptions if they are not overridden by input data: (1) costs are referenced to the date of the boiler/gasifier purchase, (2) 40-h workweek with no overtime, (3) constant 8% per year simple interest for calculating interest during construction, and (4) single-unit

plant. Input options have been included to allow modifications to boiler plant cost-model data, to escalation data, and to calculated costs at the time of program execution (blocks 3, 5, and 7).

In block 2, the cost-model data for the type of plant specified by the input data are retrieved from the COMO data file. If a cost-model data set for the type of plant specified is not found, a diagnostic message will be printed, and the code will select the last plant type on the COMO file as a default.

In block 3, the user has the option to read in, at program execution time, values that replace most of the constants or factors in the cost-model data set and in the MAIN program. The unadjusted reference costs stored in the cost-model data set may be modified at this point, if desired. This option is also used to specify the time period from which historical equipment, labor, and materials cost data are to be used in calculating escalation rates for cost indices. A list of the variables capable of adjustment is given in Chap. 5.

In block 4, the historical equipment, labor, and materials cost data for the specified city are retrieved from the LAMA data file, and escalation rates are calculated for use in adjusting costs to the specified location and for projecting costs to the specified dates. This calculation of escalation rates utilizes the historical data previously generated by the CONLAM auxiliary program, data from the reference plant cost model, and data stored by the main program. If the specified city is not found, a diagnostic message will be printed, and the code will select the last city on the LAMA file as a default.

In block 5, the user has the option to read in, at program execution time, values that override the equipment, labor, and materials escalation rates previously calculated in block 4. It is also possible to specify time-dependent equipment, labor, and materials escalation rates at this point. Data read in at this point continue in effect only for the current case unless retrieved as described in Chap. 5.

In block 6, the three components of each account in the plant cost model (equipment, labor, and materials at the most detailed account level) are scaled to the specified plant size, escalated and adjusted to the date of major equipment purchase, and adjusted for craft-labor overtime and

productivity. Component costs are scaled by using mathematical models that define each two-digit account cost in the plant cost model as a function of size. Component costs are escalated and adjusted to the specified city by cost indices calculated from the data developed in block 4 or specified in block 5. If overtime is specified, labor costs are adjusted for premium pay and for changes in productivity: the labor costs are also adjusted for changes in straight-time productivity, if specified.

In block 7, the user has the option to read in, at program execution time, values that override the adjusted equipment, labor, and materials costs at the most detailed account levels, which have been calculated in block 6 for the specified plant. These data changes continue in effect only for the current case.

In block 8, the adjusted detailed account costs from blocks 6 and 7 are summed to the two-digit account level.

In block 9, allowances for contingencies are calculated for each two-digit cost account as percentages of corresponding two-digit account costs.

In block 10, an allowance for escalation during construction is calculated. This step utilizes the cost indices generated in blocks 4 and 5 as well as the cash flow curves provided in each plant cost model.

In block 11, an allowance for interest during construction is calculated. This step utilizes a total cumulative cash flow curve and includes the effect of interest on escalation during construction.

In block 12, all costs are summed to give the total capital investment cost of the specified plant.

In block 13, additional cumulative cash flow information is developed for use in block 14.

In block 14, the final cost report is printed. The amount of detail is optional with the user, allowing either a one-page summary at the two-digit account level, a one-page summary and a total cumulative cash flow curve and table, or a multipage listing at the detailed subaccount levels and a total cumulative cash flow curve and table.

3. COST MODELS FOR REFERENCE PLANTS

Cost model data sets are provided in INDCEPT for industrial steam boiler plants and coal-gasification plants using various coal sources and environmental controls. The cost-model data sets available are defined in Tables 3.1 and 3.2. The boiler plants listed in Table 3.1 produce 212×10^3 lbs of steam per hour (gross) at 650 psig and 750°F. The coal-gasification plants listed in Table 3.2 do not include the steam boiler. Models 57 or 58 (shown in Table 3.1) should be used if associated boiler costs are desired. Models 1 through 62 can be simulated as a single unit per plant site or as multiple units of a given size and site up to a total of four identical units per plant. Models 63 through 66 can only be simulated as a single unit per plant site. Information on how a user specifies the number of units is given in Chap. 5.

The present plant cost models were developed by ORNL using cost estimates originally developed by the Foster-Wheeler Energy Corporation.² The reference plants are assumed to be located at a hypothetical site in the New Orleans area.

The actual costs stored in the cost-model data sets are subdivided into equipment, labor, and site-related materials at the detailed sub-account level and are identified by account numbers to facilitate making modifications through the optional input data stream.

In addition to detailed reference cost data, each cost model contains scaling coefficients for each two-digit account to adjust the costs from the reference size to the size of the specific case. This is done through a classical exponential scaling relation of the form

$$\text{Factor} = a + b \left[\frac{(\text{MBtu/h})_{\text{new}}}{(\text{MBtu/h})_{\text{base}}} \right]^c$$

Typical scaling coefficients, rounded to one significant digit, are shown in Table 3.3. As there may be differences of opinion regarding appropriate values for these scaling exponents, the user can readily make changes, either permanently by modifying the cost-model data or temporarily through the optional input data stream.

Table 3.1. Industrial steam boiler plant cost-model data sets available in INDCEPT

Cost model name	Gross output (MBtu/h)	Boiler ^a	Fuel ^b	FGD ^c	FGD efficiency ^d	Particulate removal ^e
MODEL 1	250	PC	EAST	SS	94	ESP
MODEL 2	250	PC	EAST	SS	94	BH
MODEL 3	250	PC	EAST	SS	70	ESP
MODEL 4	250	PC	EAST	SS	70	BH
MODEL 5	250	PC	EAST	DA	94	ESP
MODEL 6	250	PC	EAST	DA	94	BH
MODEL 7	250	PC	EAST	DA	70	ESP
MODEL 8	250	PC	EAST	DA	70	BH
MODEL 9	250	PC	EAST	LIME	94	ESP
MODEL 10	250	PC	EAST	LIME	94	BH
MODEL 11	250	PC	EAST	LIME	70	ESP
MODEL 12	250	PC	EAST	LIME	70	BH
MODEL 13	250	PC	EAST	DRY	94	-
MODEL 14	250	PC	EAST	DRY	70	-
MODEL 15	250	SF	EAST	SS	94	ESP
MODEL 16	250	SF	EAST	SS	94	BH
MODEL 17	250	SF	EAST	SS	70	ESP
MODEL 18	250	SF	EAST	SS	70	BH
MODEL 19	250	SF	EAST	DA	94	ESP
MODEL 20	250	SF	EAST	DA	94	BH
MODEL 21	250	SF	EAST	DA	70	ESP
MODEL 22	250	SF	EAST	DA	70	BH
MODEL 23	250	SF	EAST	LIME	94	ESP
MODEL 24	250	SF	EAST	LIME	94	BH
MODEL 25	250	SF	EAST	LIME	70	ESP
MODEL 26	250	SF	EAST	LIME	70	BH
MODEL 27	250	SF	EAST	DRY	94	-
MODEL 28	250	SF	EAST	DRY	70	-
MODEL 29	250	PC	WEST	SS	94	ESP
MODEL 30	250	PC	WEST	SS	94	BH
MODEL 31	250	PC	WEST	SS	70	ESP
MODEL 32	260	PC	WEST	SS	70	BH
MODEL 33	250	PC	WEST	LIME	94	ESP
MODEL 34	250	PC	WEST	LIME	94	BH
MODEL 35	250	PC	WEST	LIME	70	ESP
MODEL 36	250	PC	WEST	LIME	70	BH
MODEL 37	250	PC	WEST	DRY	94	-
MODEL 38	250	PC	WEST	DRY	70	-
MODEL 39	250	SF	WEST	SS	94	ESP
MODEL 40	250	SF	WEST	SS	94	BH
MODEL 41	250	SF	WEST	SS	70	ESP
MODEL 42	250	SF	WEST	SS	70	BH
MODEL 43	250	SF	WEST	LIME	94	ESP
MODEL 44	250	SF	WEST	LIME	94	BH

Table 3.1. (Continued)

Cost model name	Gross output (MBtu/h)	Boiler ^a	Fuel ^b	FGD ^c	FGD efficiency ^d	Particulate removal ^e
MODEL 45	250	SF	WEST	LIME	70	ESP
MODEL 46	250	SF	WEST	LIME	70	BH
MODEL 47	250	SF	WEST	DRY	94	BH
MODEL 48	250	SF	WEST	DRY	70	BH
MODEL 49	250	AFB	EAST	-	-	ESP
MODEL 50	250	AFB	WEST	-	-	ESP
MODEL 51	250	OIL	OIL	SS	94	ESP
MODEL 52	250	OIL	OIL	SS	70	ESP
MODEL 53	250	OIL	OIL	LIME	94	ESP
MODEL 54	250	OIL	OIL	LIME	70	ESP
MODEL 55	250	OIL	OIL	DRY	94	ESP
MODEL 56	250	OIL	OIL	DRY	70	ESP
MODEL 57	250	GAS	LBG	-	-	-
MODEL 58	250	GAS	MBG	-	-	-

^aType of Boiler

PC - Pulverized-coal fired
 SF - Stoker-fired
 AFB - Atmospheric fluidized bed
 OIL - Oil-fired
 GAS - Gas-fired

^bType of Fuel

EAST - Eastern high-sulfur bituminous coal
 WEST - Western low-sulfur subbituminous coal
 OIL - No. 6 oil (Bunker C)
 LBG - Low-Btu gas
 MBG - Medium-Btu gas

^cType of Flue Gas Desulfurization (FGD) System

SS - Sodium scrubbing
 DA - Dual alkali
 LIME - Lime/limestone scrubbing (conventional tower and jet bubbling reactor)
 DRY - Dry FGD system

^dEfficiency of FGD

70 - 70% removal of SO₂
 94 - 94% removal of SO₂

^eMethod of Particulate Removal

ESP - Electrostatic precipitator
 BH - Baghouse

Table 3.2. Coal-gasification plant cost-model
data sets available in INDCEPT

Cost model name	Net output (MBtu/h)	Product gas ^a	Fuel ^b	Plant ^c
MODEL 59	299	MBG	EAST	Small on-site coal-gasification plant dedicated to provide fuel for a single industrial steam boiler plant
MODEL 60	299	MBG	WEST	
MODEL 61	316	LBG	EAST	
MODEL 62	316	LBG	WEST	
MODEL 63	2300	LBG	EAST	Large central coal-gasification plant providing fuel for several distributed industrial steam boiler plants
MODEL 64	2300	LBG	WEST	
MODEL 65	2300	MBG	EAST	
MODEL 66	2300	MBG	WEST	

^aProduct gas

MBG - Medium-Btu gas

LBG - Low-Btu gas

^bFuel

EAST - Eastern high-sulfur bituminous coal

WEST - Western low-sulfur subbituminous coal

^cGasifier type

MODELS 59-60 - Koppers-Totzek

MODEL 61 - Wellman-Galusha

MODEL 62 - Stoic

MODELS 63-66 - Texaco

Table 3.3. Typical scaling coefficients for unit-size adjustments

Account	a	b	c
20	0.0	1.0	0.6
30	0.0	1.0	0.7
40	0.0	1.0	0.5
50	0.0	1.0	0.6
60	0.0	1.0	0.7
70	0.0	1.0	0.9
90	0.0	1.0	0.7

The calculation of allowances for interest and escalation during construction requires a cash flow curve for each two-digit direct and indirect cost account. A set of cash flow curves is provided with each cost-model data set. The assumed cash flow curve is illustrated in Fig. 3.1. These cash flow curves are assumed to be the same for all accounts and all types of plants. The curves are normalized so that the range for both axes is from zero to one. The time zero corresponds to the date of placing the order for the major equipment (i.e., boiler or gasifier). The time 0.1 corresponds to the date of the start of actual construction, and the time 1.0 corresponds to the date of initial commercial operation. These three dates - major equipment purchase, start of on-site construction, and commercial operation - are part of the standard input data specified by the program user. The INDCEPT code remaps the cash flow curves over the user-specified time periods.

Multiple identical units in the same plant and on the same site can be modeled through a set of multipliers provided in each cost model. Each detailed cost account has a set of four multipliers available. One of the four multipliers is selected for each account depending on the number of units specified. The cost model for each type of plant also contains relative distributions of equipment, labor, and materials, which are used as weighting factors in calculating weighted-average cost indices for adjusting reference costs to other locations and for projecting future costs.

Fig. 3.1. Typical cumulative cash flow curve.

Each cost model also includes equipment, labor, and materials rates for the reference plant cost estimate; arrays defining the number of accounts; and tables of account headings.

Specific data in the cost-model data sets can be altered temporarily at program execution time through the optional input feature. This important feature is discussed in greater detail in Chap. 5 and is illustrated in Chap. 6. Permanent modification of cost-model data is accomplished through use of the IND-TAC auxiliary program described in Appendix A.

4. COST-INDEX DATA

Historical cost data for equipment, labor, and site-related materials for 20 U.S. cities, two Canadian cities, and a hypothetical Middletown site are stored in the LAMA data file by the CONLAM auxiliary program described in Appendix B. These locations are identified and illustrated on the map in Fig. 4.1. Middletown is represented by equally-weighted averages of cost data from Boston, New York, and Philadelphia. The file contains cost data for the past 15 years in six-month intervals.

The data used to generate factory equipment cost indices consist of the producer price index for steel mill products, SIC Code 10-13; the hourly earnings index in the electrical equipment and supplies industry,

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1 ATLANTA	7 CLEVELAND	13 MINNEAPOLIS	19 SAN FRANCISCO
2 BALTIMORE	8 DALLAS	14 NEW ORLEANS	20 SEATTLE
3 BIRMINGHAM	9 DENVER	15 NEW YORK	21 MONTREAL
4 BOSTON	10 DETROIT	16 PHILADELPHIA	22 TORONTO
5 CHICAGO	11 KANSAS CITY	17 PITTSBURGH	23 MIDDLETOWN
6 CINCINNATI	12 LOS ANGELES	18 ST. LOUIS	

Fig. 4.1. Cities for which historical equipment, labor, and materials cost data are stored in INDCEPT.

SIC Code 36; and the hourly earnings index in the steam engine and turbine industry, SIC Code 3511. These data are obtained from U.S. Department of Labor, Bureau of Labor Statistics publications.³⁻⁵ Unlike the labor and site-related materials data, the equipment data are the same for all cities. This is done in recognition of the limited number of possible equipment suppliers.

A white-collar wage index is also stored in the LAMA data file. It is obtained from white-collar wage escalation data presented in the Bureau of Labor Statistics publication "National Survey of Professional, Administrative, Technical, and Clerical Pay."⁶ Like factory equipment data, it is the same for all cities and is used to adjust all noncraft labor costs.

The craft labor cost data consist of hourly rates (including union-negotiated fringe benefits, but not including employers' contributions for social security and workmen's compensation insurance) for 16 classifications of craft labor listed in Appendix B. The materials cost data consist of market quotations for seven classifications of site-related materials. The craft labor and materials data for all locations except Middletown are obtained from *Engineering News-Record*.⁷

The cost data in the LAMA file are retrieved by the INDCEPT program and are used with data on the relative distribution of equipment, labor, and materials included in the cost model for each plant type to calculate indices for adjusting capital investment costs at the reference site to costs at any of the other 22 cities and to calculate escalation rates.

5. DATA INPUT

Preceding the first data card of any case, any number of comment cards can be included by placing a "C" in column 1 of each card. The program will print these comments at the top of the first output page if space is available or on a separate page if more than a few lines of comments are read in.

Blank coding forms are shown in Figs. 5.1 and 5.2 at the end of this chapter, and their uses are illustrated in Chap. 6.

5.1 Standard Input Data

The first card contains the standard input data for a case and the optional output and nonstandard input flags. Figure 5.1 shows the form of the cards. Any number of cases can be processed in one run, subject to time and output limitations. The entries on this card are the following:

Column	Variable name	Description
1-4	SIZE	The unit rating, or size, in millions of Btu/h (MBtu/h), right justified in the field. Format I4
6-13	TYPE	Plant model name (see Tables 3.1 and 3.2), left justified in the field. Format A8
15-30	CITY	The city where the plant is to be located (see Fig. 4.1), left justified in the field. Format 2A8
32-39	IDENT	Any alphanumeric data. Format A8
41-47	YREQP	Date major equipment (i.e., boiler or gasifier) is purchased. Format F7.3
48-54	YRCON	Date construction is started. Format F7.3
55-61	YRCOP	Date of initial commercial operation. Format F7.3
62-66	RIB	Average annual interest rate for interest during construction (in percent). If not input, 8%/year will be used. Format F5.3
68	ILAZ	Flag for saving and retrieving optional NAMELIST input data for use in subsequent cases (IFLAG>0): 0 - NAMELIST input data are neither saved nor retrieved 1 - Save NAMELIST input data for use in subsequent cases

Column	Variable name	Description
		<ul style="list-style-type: none"> 2 - Retrieve NAMELIST input data that have been saved in a previous case 3 - Retrieve NAMELIST input data that have been saved in a previous case and read additional NAMELIST input data
70	IFLAG	<p>Flag for reading optional NAMELIST input data:</p> <ul style="list-style-type: none"> 0 - No NAMELIST input 1 - Permits changing YFIRST and YLAST prior to the analysis of historical equipment, labor, and materials cost data and permits overriding certain data stored in the cost models and in the main program prior to the detailed cost calculations 2 - Permits overriding calculated direct and indirect costs after adjustment for size, time, location, number of units, and escalation to date of major equipment purchase 3 - Two NAMELIST calls. The first is identical to IFLAG=1, and the second is identical to IFLAG=2
72	IOF	<p>Flag for optional output:</p> <ul style="list-style-type: none"> 0 - Two-digit-level summary output only 1 - Two-digit-level summary output with cumulative cash flow plot and table 2 - Complete cost breakdown with cumulative cash flow plot and table
74	IESC	<p>Flag for escalation during construction:</p> <ul style="list-style-type: none"> 0 - All cost accounts are escalated from date of reference case to date of major equipment purchase, and escalation during construction is shown as a separate lump-sum item 1 - All cost accounts include implicitly both escalation from date of reference case to date of major equipment purchase and escalation during construction 2 - All cost accounts are escalated from date of reference case to date of major equipment purchase, with no allowance for escalation during construction
76	IBS	<p>Flag to specify time-dependent escalation data:</p> <ul style="list-style-type: none"> 0 - No input data are expected

Column	Variable name	Description
		1 - Input data are expected and will be saved for subsequent cases
		2 - Retrieve data used when IBS was 1
78	IAC	Flag to specify type of interest:
		0 - Simple interest
		1 - Compound interest
80	ISTACK	Flag to specify total number of identical boilers or gasifiers:
		1 - Single-unit plant
		2 - Two-unit plant
		3 - Three-unit plant
		4 - Four-unit plant

5.2 Nonstandard Input Data

Specific data stored in the cost-model data sets and the main program and certain calculated costs can be changed at program execution time for one case or for a series of cases by setting the flags, IFLAG and ILAZ, on the standard input data card. These changes are effective for the current case only unless indicated by the ILAZ variable. The NAMELIST cards have the following form:

Card	Column	Description
2	2-8	&CONOPT - This identifies the following as a NAMELIST named CONOPT that contains optional data
2	10-80	Data changes start with this card in column 10; data items are separated by commas. The form of the data may be (1) variable name = constant, where the variable name may be a subscripted array name or a single variable name; (2) array name = set of constants (separated by commas). The array name is not subscripted. The number of constants must be less than or equal to the number of elements in the array. Successive occurrences of the same constant can be represented in the form k*constant. The last data entry is followed by a comma

3 or 2-80 If required, columns 2-80 of additional cards can be used
more with each data item separated by commas

Last 2-5 & END must be the last card for each set of NAMELIST data

Lists and descriptions of the variables and arrays that can be changed by the NAMELIST input option for the various values of IFLAG follow. Examples of the use of this option and the save-and-retrieve option (ILAZ>0) are presented in Chap. 6. The following variables may be changed when IFLAG=1 and in the first NAMELIST call when IFLAG=3:

Variable name	Description
AA(I,J)	Sealing coefficients for adjusting the direct and indirect costs as a function of size according to the relation

$$a + b \left[\frac{(\text{MBtu/h})_{\text{new}}}{(\text{MBtu/h})_{\text{base}}} \right]^c$$

for each two-digit account. The first dimension, I, varies from 1 to 3 representing a, b, and c, respectively. The second dimension, J, represents the two-digit accounts such that J=1,N for accounts 20 through 90 and N = number of two-digit accounts.

APC(I)	Initial productivity of labor at input location at the reference year of the cost model for each two-digit direct and indirect cost account such that I=1,N for accounts 20-90. Productivity is modeled by the equation:
--------	--

$$\text{PRODUCTIVITY} = \text{APC}(I) + \text{BPC}(I) \cdot \Delta \text{TIME}$$

where ΔTIME is time in years between major equipment purchase and reference year of the cost model.

BPC(I)	Change in productivity of site labor at input location per unit of time, for each two-digit direct and indirect cost account. I=1,N for accounts 20-90, see equation given for variable APC(I).
--------	---

CFCA(I,J)	Cash flow data for each two-digit direct and indirect cost account (I=2,N+1) in each of the 50 time periods between the major equipment purchase date and commercial operation date (J=1,50). The values when I=1 are the fraction of the design and construction period
-----------	--

<u>Variable name</u>	<u>Description</u>
COB(I) COS(I)	Contractor's overhead burden factor for each two-digit direct and indirect cost account in the reference model (COB) and the specific case (COS). I=1,N for accounts 20-90.
CONTL(I) CONTM(I) CONTE(I)	Contingency percentage for labor, materials, and equipment, respectively, for each two-digit direct and indirect cost account.
D(I,J)	Array containing lowest-digit-account direct and indirect costs (in thousands) divided into equipment, labor, and materials components (I=1,3) for a given account (J=1, 60) in the reference plant cost model
DEOT(I)	Coefficient for calculating the overall efficiency of an overtime workweek for each two-digit direct and indirect cost account; EFF = 1.0 - DEOT (HRS - 40). I=1,N for accounts 20-90.
FACS1(I,J) FACS2(I,J) FACS3(I,J)	Weighting factors for labor, materials, and equipment, respectively, for each two-digit direct and indirect cost account. I=1,N for each two-digit account. The second dimension, J, correlates a weighting factor to a specific labor, materials, or equipment index in the LAMA file
FILS(J)	Weighting factors for combining up to 20 specified locations in a composite site (J=1,20)
	$\sum_{J=1}^{20} \text{FILS}(J) \text{ must equal } 1$
FUN(I,J)	Multiplier used to reflect multiple identical boilers or gasifiers at a common site. I ranges from 1 to 4 according to the number of boilers. A FUN-array element exists for every detailed cost account (J=1,60) as described by the D-array
HWI(J) or HW	The number of hours worked per week for each two-digit direct and indirect cost account (J=1,N) for accounts 20-90, or, alternatively, the number of hours worked per week in all the accounts
ISITE(J)	Array for site combinations up to J=20. If nonzero, the ISITE value indicates site (or city) number (see Fig. 4.1) used in conjunction with weighting factor, FILS. For example, sites 12 and 16 might be combined by setting ISITE=12,16 and FILS=0.4,0.6 for 40 and 60% weighting of the respective sites

<u>Variable name</u>	<u>Description</u>
OTP(I)	Overtime premium paid to labor (multiplier of straight-time rate) for time worked in excess of 40-h workweek for each two-digit direct and indirect cost account (I=1,N) for accounts 20-90
OVERS(I)	Overall efficiency of a nonstandard workweek for each two-digit direct and indirect cost account (I=1,N) for accounts 20-90. Use of this variable overrides the calculations using variable DEOT(I).
RINT(J)	Interest rate expressed as a decimal number for each of the fifty time periods between the major equipment purchase date and commercial operation date (J=1,50)
YFIRST	The first date to be considered in performing a linear regression on the historical equipment, labor, and materials file
YLAST	The last date to be considered in performing a linear regression on the historical equipment, labor, and materials file

The following variables may be changed when IFLAG=1,2, or 3 (either NAMELIST call):

CONTL(I)	Contingency percentage for labor, materials, and factory equipment, respectively, for each two-digit direct and indirect cost account (I=1,N) for accounts 20-90 and N = number of two-digit accounts.
CONTM(I)	
CONTE(I)	
D(I,J)	Lowest-digit account direct and indirect costs (in thousands) divided into equipment, labor, and materials (I=1,3) for a given account (J=1,60). When IFLAG=1 and in the first NAMELIST call when IFLAG=3, the costs in the D array represent the reference cost model. When IFLAG=2 or in the second NAMELIST call when IFLAG=3, the costs in the D array are the costs adjusted for size and location and expressed in dollars current to the major equipment purchase date
RINT(J)	Interest rate expressed as decimal number for each of the 50 time periods between the steam supply date and commercial operation date (J=1,50)

5.3. Time-dependent Escalation Data

Time-dependent escalation input can be used to alter the escalation rates and cost indices for equipment, labor, and materials. To do so requires a set of input cards which follows after the standard input and the

NAMelist cards (when used). Figure 5.2 shows the form of the cards. The first card is for factory equipment direct and indirect cost accounts. If there are more than seven two-digit direct and indirect cost accounts, then a second card continuing with the same format must be used. Labor and materials are treated in the same fashion. The "A" field in each of the two-digit accounts represents a cost index at a given point in time. The "B" field represents the escalation rate in the $(1 + \epsilon)$ form at a given point in time. If fields are left blank on the data cards, the current escalation coefficients in these fields will not be altered. The last field on the materials card is for a date written in decimal notation. This is the "effective" date for the data being input. These data may be both before and during the design and construction period.

Additional sets of cards may be used in a sequential fashion with different dates in chronological order to change escalation parameters with time. However, following the last set a card with -1. in the last field must be input. This is true even if there is only one set of cards being input.

As described in Sect. 5.1, the time-dependent escalation data input may be saved for subsequent cases.

Examples of this feature are given in Chap. 6.

[illegible]

Fig. 5.1. Standard input data format.

INDCEPT

ORNL-DWG 82-6133 ETD

[illegible]

Fig. 5.2. Time-dependent escalation input format.

6. EXAMPLE PROBLEMS

This section illustrates the preparation of input data for the INDCEPT program. Eight examples are presented which are designed to help clarify previous discussion concerning the various options, the use of the NAMELIST input feature, and the input of time-dependent escalation data. Input data for all examples are shown in Fig. 6.1; complete output listings for problem 1 follows.

Example problems 1 and 2 are simple cases of single- and multiple-unit boiler plants. The IOF output variable is set to produce a complete output listing for problem 1 and a two-digit-level summary for problem 2.

Example problem 3 illustrates the use of the NAMELIST feature for a single-unit boiler plant. As determined by the value of IFLAG, the cost of the boiler in Account 320 will be set to the value in the NAMELIST prior to the detailed cost calculations. The output option has been set to produce a two-digit-level summary and a cash flow plot and table.

Example problem 4 is a single-unit boiler plant using NAMELIST to modify the starting date for the LAMA file linear regression analysis. For the four-unit boiler plant, ILAZ=2 allows the NAMELIST data used for the single-unit plant to be retrieved.

Example problem 5 is a single-unit illustration of the time-dependent escalation data input option. Variable IBS is set to 1, which causes the escalation data cards to be read and saved internally, should a subsequent case need the same escalation input. The "effective" date for data input can be earlier, the same as, or later than the major equipment purchase date. The effect of the time-dependent escalation data is to cause escalation of equipment and materials to occur at a rate of 8% per year and escalation of labor at 10% per year starting in 1982.

Example problem 6 demonstrates the time-dependent escalation data input feature for multiple cases. By setting IBS=2 for the second case, the data input for the first case is retrieved and applied to the second case. Only the labor component is to be adjusted through the escalation data input. However, the number of cards in the input sequence must remain the same. The time-dependent escalation input cards must follow the

REQUEST NO.		NAME		INDCEPT DATA SHEET																																																										FLAG OPTIONS																	
SIZE (Right Adjust) (14)	MODEL NAME (Left Adjust) (18)	CITY (Left Adjust) (218)																														EXTRA IDENTIFICATION (18)	DATE BOILER PURCHASED (F7.3)	DATE CONSTRUCTION BEGINS (F7.3)	DATE COMMERCIAL OPERATION (F7.3)	% INTEREST RATE (F5.3)	ILV	IFLAG	IOF	IBSC	IBS	IAC	ISTACK																																				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
C	EXAMPLE PROBLEM 5	NEW ORLEANS																														PROB 5	198200	198300	198500	15000	0	0	2	0	1	1	1																																				

Fig. 6.1. (continued)

INDCEPT

ORNL-DWG 82-6134 (Part 3) ETD

[illegible]

Fig. 6.1. (continued)

FLAG OPTIONS

[illegible]

Fig. 6.1. (continued)

INDCEPT

[illegible]

Fig. 6.1. (continued)

FLAG OPTIONS

32

Fig. 6.1. (continued)

INDCEPT

[illegible]

Fig. 6.1. (continued)

[illegible]

Fig. 6.1. (continued)

INDCEPT

[illegible]

Fig. 6.1. (continued)

Fig. 6.1. (continued)

C EXAMPLE PROBLEM 1

250 MODEL 6 NEW ORLEANS PROB 1 198200 198300 198500 15000 0 0 2 0 0 1 1

INDEPENDENT DATA SETS

PLANT TYPE CODES

1 MODEL 6 9-18-81

CITY NAME CODES

1	ATLANTA	GEORGIA
2	BALTIMORE	MARYLAND
3	BIRMINGHAM	ALABAMA
4	BOSTON	MASSACHUSETTS
5	CHICAGO	ILLINOIS
6	CINCINNATI	OHIO
7	CLEVELAND	OHIO
8	DALLAS	TEXAS
9	DENVER	COLORADO
10	DETROIT	MICHIGAN
11	KANSAS CITY	KANSAS
12	LOS ANGELES	CALIFORNIA
13	MINNEAPOLIS	MINNESOTA
14	NEW ORLEANS	LOUISIANA
15	NEW YORK	NEW YORK
16	PHILADELPHIA	PENNSYLVANIA
17	PITTSBURGH	PENNSYLVANIA
18	ST. LOUIS	MISSOURI
19	SAN FRANCISCO	CALIFORNIA
20	SEATTLE	WASHINGTON
21	MONTREAL	CANADA
22	TORONTO	CANADA
23	MIDDLETOWN	USA

IF THE PLANT TYPE OR CITY SELECTED WAS NOT USED
IN COMPUTATIONS, CHECK SPELLING AND FIELD JUSTIFICATION
WITH THE AVAILABLE PLANT TYPE AND CITY NAME CODES

C EXAMPLE PROBLEM 1

DATA CARD COLUMNS USED

1--4	6-----13	15-----30	32-----39	41-----47	48-----54	55-----61	62--66	68	70	72	74	76	78	80
SIZE	MODEL	CITY	EXTRA ID	YR EQP	YR CON	YR COP	% INT	ILAZ	IFLAG	IOF	IESC	IHS	IAC	ISTACK
250	MODEL 6	NEW ORLEANS	PROB 1	1982.000	1983.000	1985.000	15.000	0	0	2	0	0	1	1

DATE 09-28-81 I N D C E P T C O S T E S T I M A T E S
 1 UNIT CAPITAL INVESTMENT SUMMARY (THOUSANDS OF DOLLARS)
 1X 250 MBTU/HR MODEL 6 () PLANT AT NEW ORLEANS PROB 1
 PULVERIZED COAL, EASTERN, DUAL ALKALI FGD, 94% EFF, BAGHOUSE PARTICULATE REMOVAL
 COST BASIS: YEAR OF MAJOR EQP. PURCHASE
 DESIGN & CONSTRUCTION PERIOD: MAJOR EQP. PURCHASE: 1982.00
 START OF CONSTRUCTION: 1983.00
 COMMERCIAL OPERATION: 1985.00

CONIV CALLED - DATA FIT DONE ON LOUISIANA NEW ORLEANS

SITE RATE AND ESCALATION USED IN COST PROJECTIONS YFIRST = 1966.50 YLAST = 1981.00

ACCT	20	ACCT	30	ACCT	40	ACCT	50	ACCT	60	ACCT	70	ACCT	90
A	B	A	B	A	B	A	B	A	B	A	B	A	B
*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
E 304.	1.083	304.	1.083	304.	1.083	304.	1.083	304.	1.083	304.	1.083	304.	1.083
L 15.0	1.082	15.0	1.082	15.0	1.082	15.0	1.082	15.0	1.082	15.0	1.082	15.0	1.082
M 27.5	1.074	27.5	1.074	27.5	1.074	27.5	1.074	27.5	1.074	27.5	1.074	27.5	1.074

DATE 09-28-81 I N D E C E P T C O S T E S T I M A T I E S
 1 UNIT CAPITAL INVESTMENT SUMMARY (THOUSANDS OF DOLLARS)
 1X 250 MBTU/HR MODEL 6 (9-18-81) PLANT AT NEW ORLEANS PROB 1
 PULVERIZED COAL, EASTERN, DUAL ALKALI FGD, 94% EFF, BAGHOUSE PARTICULATE REMOVAL
 COST BASIS: YEAR OF MAJOR EQP. PURCHASE
 DESIGN & CONSTRUCTION PERIOD: MAJOR EQP. PURCHASE: 1982.00
 START OF CONSTRUCTION: 1983.00
 COMMERCIAL OPERATION: 1985.00

ACCOUNT NUMBER	A C C O U N T T I T L E	TOTAL COSTS	EQUIPMENT COSTS	LABOR MANHOURS	MATERIAL COSTS
20	LAND AND SITE WORK	324	5. (	12.)	190. 133.
30	BOILER PLANT	11053	6546. (	159.)	2329. 2178.
40	BOILER SUPPORT FACILITIES	4488	2445. (	77.)	1138. 905.
50	PARTICULATE REMOVAL SYSTEM	1997	1086. (	29.)	434. 478.
60	FLUE GAS DESULFURIZATION	2408	975. (	43.)	644. 789.
70	SUPPORT FACILITIES	804	112. (	19.)	279. 222.
	SUBTOTAL	21074	11354. (	339.)	5014. 4705.
90	INDIRECT COSTS	10407			
	SUBTOTAL	10407			
	DIRECT & INDIRECT COSTS	31481			
	CONTINGENCY ALLOWANCE	6296			
	TOTAL DIRECT & INDIRECT COSTS	37777			
	ESCALATION DURING CONSTRUCTION (8.1%/YR)	6478			
	TOTAL ESCALATED DIRECT & INDIRECT COSTS	44255			
	INTEREST DURING CONSTRUCTION COMPOUND (15.000%/YR)				
	ON DIRECT & INDIRECT COSTS	5626			
	ON ESCALATION DURING CONSTRUCTION	441			
	TOTAL INTEREST DURING CONSTRUCTION	6467			
	TOTAL PLANT CAPITAL INVESTMENT	50722			

WEIGHTED AVERAGE ESCALATION (%/YR)		
EQUIPMENT	LABOR	MATERIAL
8.3	8.2	7.4

DATE 09-28-81 I N D C E P T C O S T E S T I M A T E S

1 UNIT CAPITAL INVESTMENT DETAIL COSTS (THOUSANDS OF DOLLARS)

1X 250 MBTU/HR MODEL 6 (9-18-81) PLANT AT: NEW ORLEANS PROB 1

PULVERIZED COAL, EASTERN, DUAL ALKALI FGD, 94% EFF, BAGHOUSE PARTICULATE REMOVAL

COST BASIS: YEAR OF MAJOR EQP. PURCHASE

MAJOR EQP. PURCHASE: 1982.00

START OF CONSTRUCTION: 1983.00

COMMERCIAL OPERATION: 1985.00

ACCOUNT NUMBER	ACCOUNT TITLE	FACTORY EQUIPMENT	SITE LABOR	SITE MATERIALS	TOTAL
20	LAND AND SITE WORK				
210	SITE WORK	\$ 0.	\$ 190.	\$ 133.	324.
220	LAND	\$ 0.	\$ 0.	\$ 0.	0.
SUBTOTAL FOR ACCOUNT		\$ 0.	\$ 190.	\$ 133.	\$ 324.
CONTINGENCY (20.0%EQP-20.0%LABOR-20.0%MTL)		0.	38.	27.	65.
TOTAL FOR ACCOUNT 20		0.	228.	160.	388.

41

DATE 09-28-81 I N D C E P T C O S T E S T I M A T E S

1 UNIT CAPITAL INVESTMENT DETAIL COSTS (THOUSANDS OF DOLLARS)

1X 250 MBTU/HR MODEL 6 (9-18-81) PLANT AT: NEW ORLEANS PROB 1

PULVERIZED COAL, EASTERN, DUAL ALKALI FGD, 94% EFF, BAGHOUSE PARTICULATE REMOVAL

COST BASIS: YEAR OF MAJOR EQP. PURCHASE

MAJOR EQP. PURCHASE: 1982.00

START OF CONSTRUCTION: 1983.00

COMMERCIAL OPERATION: 1985.00

ACCOUNT NUMBER	ACCOUNT TITLE	FACTORY EQUIPMENT	SITE LABOR	SITE MATERIALS	TOTAL
30	BOILER PLANT				
310	BOILER HOUSE	\$ 0.	\$ 476.	\$ 429.	905.
320	BOILER	\$ 4420.	\$ 1082.	\$ 994.	6496.
330	FANS	\$ 233.	\$ 97.	\$ 129.	459.
340	STACK	\$ 515.	\$ 27.	\$ 43.	585.
350	PULVERIZER	\$ 1116.	\$ 559.	\$ 392.	2067.
360	BOILER FEEDWATER SYSTEM	\$ 262.	\$ 88.	\$ 191.	541.
SUBTOTAL FOR ACCOUNT		\$ 6546.	\$ 2329.	\$ 2178.	\$ 11053.
CONTINGENCY (20.0%EQP-20.0%LABOR-20.0%MTL)		1309.	466.	436.	2211.
TOTAL FOR ACCOUNT 30		7855.	2795.	2614.	13264.

DATE 09-28-81 IN D C E P T C O S T E S T I M A T E S
 1 UNIT CAPITAL INVESTMENT DETAIL COSTS (THOUSANDS OF DOLLARS)
 1X 250 MBTU/HR MODEL 6 (9-18-81) PLANT AT: NEW ORLEANS PROB 1
 PULVERIZED COAL, EASTERN, DUAL ALKALI FGD, 94% EFF, BAGHOUSE PARTICULATE REMOVAL
 COST BASIS: YEAR OF MAJOR EQP. PURCHASE

MAJOR EQP. PURCHASE: 1982.00
 START OF CONSTRUCTION: 1983.00
 COMMERCIAL OPERATION: 1985.00

ACCOUNT NUMBER	ACCOUNT TITLE	FACTORY EQUIPMENT	SITE LABOR	SITE MATERIALS	TOTAL
40	BOILER SUPPORT FACILITIES				
410	COAL HANDLING SYSTEM	\$ 1806.	\$ 776.	\$ 465.	3047.
420	ASH HANDLING SYSTEM	\$ 460.	\$ 216.	\$ 322.	999.
430	LIPESTONE HANDLING SYSTEM	\$ 0.	\$ 0.	\$ 0.	0.
440	OIL STORAGE TANK	\$ 0.	\$ 0.	\$ 0.	0.
450	WASTE WATER TREATING	\$ 179.	\$ 146.	\$ 118.	443.
	SUBTOTAL FOR ACCOUNT	\$ 2445.	\$ 1138.	\$ 905.	\$ 4488.
	CONTINGENCY (20.0% EQP-20.0% LABOR-20.0% MTL)	\$ 489.	\$ 228.	\$ 191.	\$ 898.
	TOTAL FOR ACCOUNT 40	\$ 2934.	\$ 1366.	\$ 1096.	\$ 5396.

DATE 09-28-81 IN D C E P T C O S T E S T I M A T E S
 1 UNIT CAPITAL INVESTMENT DETAIL COSTS (THOUSANDS OF DOLLARS)
 1X 250 MBTU/HR MODEL 6 (9-18-81) PLANT AT: NEW ORLEANS PROB 1
 PULVERIZED COAL, EASTERN, DUAL ALKALI FGD, 94% EFF, BAGHOUSE PARTICULATE REMOVAL
 COST BASIS: YEAR OF MAJOR EQP. PURCHASE

MAJOR EQP. PURCHASE: 1982.00
 START OF CONSTRUCTION: 1983.00
 COMMERCIAL OPERATION: 1985.00

ACCOUNT NUMBER	ACCOUNT TITLE	FACTORY EQUIPMENT	SITE LABOR	SITE MATERIALS	TOTAL
50	PARTICULATE REMOVAL SYSTEM				
510	ELECTROSTATIC PRECIPITATOR	\$ 0.	\$ 0.	\$ 0.	0.
520	BAGHOUSE	\$ 1066.	\$ 434.	\$ 478.	1997.
	SUBTOTAL FOR ACCOUNT	\$ 1066.	\$ 434.	\$ 478.	\$ 1997.
	CONTINGENCY (20.0% EQP-20.0% LABOR-20.0% MTL)	\$ 217.	\$ 87.	\$ 96.	\$ 399.
	TOTAL FOR ACCOUNT 50	\$ 1283.	\$ 521.	\$ 573.	\$ 2397.

DATE 09-28-81 INDCPT COST ESTIMATES
 1 UNIT CAPITAL INVESTMENT DETAIL COSTS (THOUSANDS OF DOLLARS)
 1X 250 MBTU/HR MODEL 6 (9-18-81) PLANT AT: NEW ORLEANS PROB 1
 PULVERIZED COAL, EASTERN, DUAL ALKALI FGD, 94% EFF, BAGHOUSE PARTICULATE REMOVAL
 COST BASIS: YEAR OF MAJOR EQP. PURCHASE

MAJOR EQP. PURCHASE: 1982.00
 START OF CONSTRUCTION: 1983.00
 COMMERCIAL OPERATION: 1985.00

ACCOUNT NUMBER	ACCOUNT TITLE	FACTORY EQUIPMENT	SITE LABOR	SITE MATERIALS	TOTAL
60	FLUE GAS DESULFURIZATION				
610	ABSORBERS	\$ 720.	\$ 465.	\$ 585.	1771.
620	LIQUID HANDLING SYSTEM	\$ 152.	\$ 113.	\$ 129.	394.
630	SCRUBENT HANDLING SYSTEM	\$ 103.	\$ 76.	\$ 75.	254.
640	WASTE HANDLING	\$ 0.	\$ 0.	\$ 0.	0.
650	MISCELLANEOUS	\$ 0.	\$ 0.	\$ 0.	0.
	SUBTOTAL FOR ACCOUNT	\$ 975.	\$ 644.	\$ 789.	\$ 2408.
	CONTINGENCY (20.0%EQP-20.0%LABOR-20.0%MTL)	\$ 195.	\$ 129.	\$ 158.	\$ 482.
	TOTAL FOR ACCOUNT 60	\$ 1170.	\$ 772.	\$ 947.	\$ 2889.

DATE 09-28-81 INDCPT COST ESTIMATES
 1 UNIT CAPITAL INVESTMENT DETAIL COSTS (THOUSANDS OF DOLLARS)
 1X 250 MBTU/HR MODEL 6 (9-18-81) PLANT AT: NEW ORLEANS PROB 1
 PULVERIZED COAL, EASTERN, DUAL ALKALI FGD, 94% EFF, BAGHOUSE PARTICULATE REMOVAL
 COST BASIS: YEAR OF MAJOR EQP. PURCHASE

MAJOR EQP. PURCHASE: 1982.00
 START OF CONSTRUCTION: 1983.00
 COMMERCIAL OPERATION: 1985.00

ACCOUNT NUMBER	ACCOUNT TITLE	FACTORY EQUIPMENT	SITE LABOR	SITE MATERIALS	TOTAL
70	SUPPORT FACILITIES				
710	FIRE PROTECTION SYSTEM	\$ 31.	\$ 41.	\$ 34.	107.
720	MOBILE SOLIDS HANDLING EQUIPMENT	\$ 217.	\$ 0.	\$ 0.	217.
730	FACILITIES BUILDING	\$ 0.	\$ 87.	\$ 81.	167.
740	ELECTRICAL	\$ 54.	\$ 108.	\$ 54.	216.
750	INTERCONNECTING PIPING	\$ 0.	\$ 43.	\$ 54.	97.
	SUBTOTAL FOR ACCOUNT	\$ 302.	\$ 279.	\$ 222.	\$ 804.
	CONTINGENCY (20.0%EQP-20.0%LABOR-20.0%MTL)	\$ 60.	\$ 56.	\$ 44.	\$ 161.
	TOTAL FOR ACCOUNT 70	\$ 362.	\$ 335.	\$ 267.	\$ 964.

DATE 09-28-81 IN D C E P T C O S T E S T I M A T E S
 1 UNIT CAPITAL INVESTMENT DETAIL COSTS (THOUSANDS OF DOLLARS)
 1X 250 MBTU/HR MODEL 6 (9-18-81) PLANT AT: NEW ORLEANS PROB 1
 PULVERIZED COAL, EASTERN, DUAL ALKA. I FSD, 94% EFF, BAGHOUSE PARTICULATE REMOVAL
 COST BASIS: YEAR OF MAJOR EQP. PURCHASE

MAJOR EQP. PURCHASE: 1982.00
 START OF CONSTRUCTION: 1983.00
 COMMERCIAL OPERATION: 1985.00

ACCOUNT NUMBER	ACCOUNT TITLE	FACTORY EQUIPMENT	SITE LABOR	SITE MATERIALS	TOTAL
90	INDIRECT COSTS				
910	FIELD INDIRECT COSTS	\$ 0.	\$ 5519.	\$ 0.	6519.
920	HOME OFFICE COSTS	\$ 1519.	\$ 1566.	\$ 629.	3715.
930	START-UP SUPERVISION	\$ 0.	\$ 173.	\$ 0.	173.
SUBTOTAL FOR ACCOUNT		\$ 1519.	\$ 8259.	\$ 629.	\$ 10407.
CONTINGENCY (20.0% EQP-20.0% LABOR-20.0% MTL) . . .		34.	1852.	126.	2081.
TOTAL FOR ACCOUNT 90		\$ 1823.	\$ 9911.	\$ 755.	\$ 12489.

DATE 09-28-81 I N D C E P T C O S T E S T I M A T E S
 1 UNIT CAPITAL INVESTMENT DETAIL COSTS (THOUSANDS OF DOLLARS)
 1X 250 MBTU/HR MODEL 6 (9-18-81) PLANT AT: NEW ORLEANS PROB 1
 PULVERIZED COAL, EASTERN, DUAL ALKALI FGD, 94% EFF, BAGHOUSE PARTICULATE REMOVAL
 COST BASIS: YEAR OF MAJOR EQP. PURCHASE

MAJOR EQP. PURCHASE: 1982.00
 START OF CONSTRUCTION: 1983.00
 COMMERCIAL OPERATION: 1985.00

DATE 09-28-81 I N D C E P T C O S T E S T I M A T E S

1 UNIT CAPITAL INVESTMENT DETAIL COSTS (THOUSANDS OF DOLLARS)

1X 250 MBTU/HR MODEL 6 ('9-18-81) PLANT AT: NEW ORLEANS PFDB 1
 PULVERIZED COAL, EASTERN, DUAL ALKALI FGD, 94% EFF, BAGHOUSE PARTICULATE REMOVAL
 COST BASIS: YEAR OF MAJOR EQP. PURCHASE

MAJOR EQP. PURCHASE: 1982.00
 START OF CONSTRUCTION: 1983.00
 COMMERCIAL OPERATION: 1985.00

C U M U L A T I V E C A S H F L O W

BOTH THE CASH FLOW CURVE SHOWN ABOVE AND THE FOLLOWING CASH FLOW TABLE
 HAVE COSTS EXPRESSED AS TOTAL COST INCURRED TO DATE (INCLUDING INTEREST CHARGES TO DATE).

DATE	COST TO DATE (THOUSANDS OF DOLLARS)
1982.00	0.
1982.06	0.
1982.12	393.
1982.18	397.
1982.24	430.
1982.30	403.
1982.36	600.
1982.42	605.
1982.48	610.
1982.54	615.
1982.60	659.
1982.66	665.
1982.72	671.
1982.78	676.
1982.84	722.
1982.90	728.
1982.96	734.
1983.02	781.
1983.08	992.
1983.14	1164.
1983.20	1298.
1983.24	1722.
1983.32	2153.
1983.38	3299.
1983.44	3789.
1983.50	4327.
1983.54	5847.
1983.62	6662.
1983.68	7874.
1983.74	9874.
1983.80	11,37.
1983.84	12431.
1983.92	15587.
1983.98	17907.
1984.04	21578.
1984.10	23528.
1984.14	25502.
1984.22	29286.
1984.28	31326.
1984.34	33391.
1984.40	36843.
1984.46	38514.
1984.52	40665.
1984.58	43072.
1984.64	44357.
1984.70	46121.
1984.76	46974.
1984.82	47931.
1984.88	49039.
1985.00	50722.

standard input data card for the first case. The standard input data card for the second case is the final card in the input stream.

Example problem 7 makes use of both the NAMELIST and time-dependent escalation input features. The NAMELIST option variables have been set to call the NAMELIST input only after the costs have undergone size, time, and location adjustment (IFLAG=2). Contingency factors for equipment, labor, and materials have been set equal to 10%. Again the effective date for escalation input data is the major equipment purchase date.

Example problem 8 combines the NAMELIST and time-dependent escalation data input features in determining the investment costs of three separate cases. The IFLAG variable is set to 3 so that there will be two NAMELIST calls; one before the detailed cost adjustments and one after. The time-dependent escalation data consist of three sets, one effective at 1980.0 prior to major equipment purchase, the second at 1982.0 at major equipment purchase, and the third at 1983.5 following major equipment purchase. This causes the escalation rates to change in 1980.0, 1982.0, and 1983.5. The -1.0 card occurs only after all the sets are input. The NAMELIST and escalation data are used in the second and third cases through the retrieval features of the ILAZ and IBS variables.

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Appendix A

INDTAC AUXILIARY PROGRAM

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INDTAC AUXILIARY PROGRAM

Auxiliary program INDTAC is used to maintain the reference plant cost-model data file, COMO, by converting a card image cost-model data set to a single unformatted binary record. Each record is 14,140 bytes in length and contains all data relating to the cost model for a particular plant type at some reference location and reference time. The INDTAC program can be used to create new records, update existing records, delete unwanted records, and list records that are on the updated file. Written in FORTRAN IV, INDTAC has approximately the same machine requirements as the INDCEPT program. INDTAC consists of only a main program, which exercises control over the option list. The data are entered on punched cards and are listed on the system printer.

Each set of data consists of about 250 cards, depending on the model. These cost-model data sets are defined as logical unit 4 (FT04F001) in the program and are read in sequentially. Each cost model has a control card which specifies the numerical position of the record on the file and a command instruction for the program. This control card is such that a new record may be added by specifying the number of the record preceding the one to be added and the letter A. A record may be changed, deleted, or listed by specifying the desired record number and C, D, or L, respectively, on the control card.

In addition to the control card for each model, there is an overall control card read from logical unit 5 (FT05F001) that instructs the program whether a completely new file is being built or whether an unformatted binary file already exists which is to be modified. A value of zero indicates the absence of an existing binary cost model file. A non-zero value indicates the existence of such a file. A new unformatted cost-model file is created on logical unit 9 (FT09F001) for each computer run regardless of the operations performed during that run.

After all records have been read in and an unformatted binary file created, an output table is listed showing the new cost-model file record sequence with the appropriate plant model name.

A description of the input cards is tabulated below.

INDTAC program input card description

No. of cards in each type	Column	Variable name	Description
INDTAC control card read from unit FT05F001			
1	1	ITAPE	Input file control. Format I1 0 - No existing binary file 1 - Existing unformatted binary file
Each INDTAC cost-model card deck read from unit FT04F001 is assembled as follows:			
1	1-2	IREC	Cost model record number on binary file. Format I2
	3	DOREC	Record control. Format A1 "A" Add (Use IREC number of model preceding one to be added) "C" Change (Use IREC number of "D" Delete specific model of "L" List interest)
1	1-16	TYPE1(I)	Model name and date of origin (I=1,2). Format 2A8
	17-23	BWE	Boiler or gasifier size (MBtu/h). Format F7.0
	24-30	YBC	Year of reference costs. Format F7.2
	31-34	PO	Fraction of time expended up to date of construction start. Format F4.2
1	1-80	TITLE	Comment card. Format 20A4
1	1-4	NAA	Number of cards to read for AA array. Format I4
	5-8	NIAR4	Number of cards to read for IAR4 array. (NIAR4<3) Format I4
	9-12	NIAR5	Number of cards to read for IAR5 array. (NIAR5<2) Format I4
	13-16	NCCD	Number of cards to read for D array. (NCCD<60) Format I4
	17-20	IAC2	Number of cards to read for AC2 array. (IAC2<12) Format I4
	21-24	IAC3	Number of cards to read for AC3 array. (IAC3<60) Format I4
	25-28	IAC4	Number of cards to read for AC4 array. (IAC4<30) Format I4

INDTAC program input card description (continued)

No. of cards in each type	Column	Variable name	Description
	29-32	IAC5	Number of cards to read for AC5 array. (IAC5(2) Format I4
1	1-3	IAR1	Number of one-digit accounts. Format I3
	1-3 4-6 7-9 10-12 13-15	IAR2(I2)	Number of two-digit accounts in each one-digit account (I2=1,5). Format 5I3
1	1-3 . . . 43-45	IAR3(I3)	Number of three-digit accounts in each two-digit account (I3=1,15). Format 15I3
NIAR4	1-3 . . . 58-60 73-80	IAR4(I4)	Number of four-digit accounts in each three-digit account (I4=1,60). Format 20I3
		IA4D(I)	Identification field. Format A8. (I=1,NIAR4)
NIAR5	1-3 . . . 58-60 73-80	IAR5(I5)	Number of five-digit accounts in each four-digit account (I5=1,30). Format 20I3
		IA5D(I)	Identification field. Format A8. (I=1,NIAR5)
1	1-8	Model name	Used only for identification on this card
	12-16	MHT	Total craft labor in thousands of man-hours for direct cost accounts for reference plant. Format I5
	17-20 . . . 41-44	MHP(I)	Craft labor in thousands of man- hours for each direct cost account (I=1,7). Format 7I4
1	1-7 . .	COB(I)	Contractor's overhead burden factor for craft labor in each two-digit account (I=1,11). Format 11F7.3

INDTAC program input card description (continued)

No. of cards in each type	Column	Variable name	Description
	. 71-77		
1	1-7 . . . 71-77	AEB(I)	Coefficient used for reference factory equipment rate in each two-digit account (I=1,11). Format 11F7.3
1	1-7 . . . 71-77	ALB(I)	Coefficient used for reference craft wage rate in each two-digit account (I=1,11). Format 11F7.3
1	1-7 . . . 71-77	AMB(I)	Coefficient used for reference site-related materials rate for each two-digit account (I=1,11). Format 11F7.3
1	1-7 . . . 71-77	XLR(I)	Wage rate for direct cost two-digit accounts implicit in the D-array. Format 11F7.3 (I=1,7)
11	1-15 16-30 31-45 65-66 73-80	AA(J,I) NAC(I) AAD(I)	Size-scaling coefficients for two-digit accounts (J=1,3, and I=1,NAA). Format 3F15.0 Two-digit account number (I=1,11). Format I2 Identification field (I=1,11). Format A8
NCCD	1-15 16-30 31-45 64-71 73-80	D(J,I) IDD(I) IDN(I)	Array containing costs at lowest-level accounts (J=1,3 and I=1,NCCD). Format 3F15.4 Account number (I=1,NCCD). Format A8 Card identification field (I=1,NCCD). Format A8
50	1-6 7-12 . . 67-72	CFCA(J,I)	Array containing cash flow curves for each two-digit cost account (J=1,12 and I=1,50). Format 12F6.3

INDTAC program input card description (continued)

No. of cards in each type	Column	Variable name	Description
16	1-6 . . . 61-66	FACS1(J,I)	Weighting factors for site labor (J=1,11 and I=1,16). Format 11F6.2
16	1-6 . . . 61-66	FACS2(J,I)	Weighting factors for site material (J=1,11 and I=1,16). Format 11F6.2
8	1-6 . . . 61-66	FACS3(J,I)	Weighting factors for factory equip- ment (J=1,11 and I=1,8). Format 11F6.2
IAC2	1-64	AC2(J,I)	Alphabetic description of two-digit accounts (J=1,8 and I=1,IAC2). Format 8A8
IAC3	1-64	AC3(J,I)	Alphabetic description of three- digit accounts (J=1,8 and I=1,IAC3). Format 8A8
IAC4	1-64	AC4(J,I)	Alphabetic description of four- digit accounts (J=1,8 and I=1,IAC4). Format 8A8
IAC5	1-64	AC5(J,I)	Alphabetic description of five- digit accounts (J=1,8 and I=1,IAC5). Format 8A8
NCCD	1-7 . . 22-28 64-72 73-80	FUN(J,I) DUM1 DUM2	Cost multipliers for multiple unit plants (J=1,4) for each detailed cost account (I=1,NCCD). Account number. Format A8 Card identification field. Format A8

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Appendix B

CONLAM AUXILIARY PROGRAM

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CONLAM AUXILIARY PROGRAM

Auxiliary program CONLAM is used to generate the data file, LAMA, containing information on historical factory equipment, craft and white collar labor, and site-related materials costs for the 23 cities shown previously in Fig. 4.1. Data for other locations can also be entered through this program as they become available. However, normal application of CONLAM will be limited to updating cost data for the existing 23 cities at regular time intervals. Six-month intervals have been used; however, other time intervals are acceptable. The LAMA file currently contains 15 years of historical data.

Factory equipment data are obtained from the U.S. Department of Labor, Bureau of Labor Statistics, and are the same for all locations, reflecting the limited market. The items used are given on the following page. Craft labor and site materials data for the 22 actual cities are obtained from *Engineering News-Record*. The hypothetical Middletown site is a composite of Boston, New York, and Philadelphia weighted equally. The craft labor and materials items are listed on the following page.

Data can be read for a maximum of 30 time periods, as specified by the user, for each of the 22 actual locations. The hypothetical Middletown site is generated internally by the CONLAM program. At the user's option, data can be read either from cards alone when initially generating a file (variable IRMOLD=1) or from an existing file in card images with update cards when updating or modifying an existing file (IRMOLD=0). In either case, one new file is produced in card images and another file is written in unformatted binary records. It is the unformatted binary record file (LAMA) that is used by the INDCEPT program. Options also exist for punching card decks of the data stored on the file and for producing the following listings: (1) card image output and (2) tabular output for equipment, labor, and materials for each site in the file. The program is designed to eliminate automatically the oldest time period as each new period is introduced, or it will add a new period if there are less than 30 total periods.

The program uses two wage duplications, as follows, by option of the user: (1) boilermaker wages are duplicated from steamfitter wages, and

(2) other crafts' wages are duplicated from bricklayer wages. This is done since *Engineering News-Record*⁷ does not include boilermaker wages or a combination of other crafts' wages. An option flag for both labor categories permits using data punched into standard input cards.

The remainder of this Appendix consists of a description of the input data requirements. When updating an existing file, Card 2 is not used; hence, the update card deck order must correspond to the city order of the old card image file.

CONLAM input card description

Card No.	Column	Variable name	Description
1	1-5	NOPER	Number of actual data points stored on file, less than or equal to MAXREC. Format I5
	6-10	MAXREC	Maximum number of time periods on file for each location, not to exceed 30. Format I5
	11-15	NCITY	Number of locations on file, presently 23. Format I5
	16-20	IRMOLD	Flag for type of input. Format I5 0 - Update existing master files 1 - Establish new master files for card input
	21-25	IPUNCH	Flag for card output. Format I5 0 - Omits card output 1 - Produces card deck
	26-30	NOLIST	Flag for listing card images. Format I5 0 - Produces list 1 - Omits list
	31-35	NOREF	Flag for table output. Format I5 0 - Produces table 1 - Omits table
	36-40	IBLMKR	Flag for boilermakers' wages. Format I5 0 - Uses steamfitters' wages 1 - Boilermakers' wages must be supplied, in B(15)
	41-45	IOCRFT	Flag for other crafts' wages. Format I5 0 - Uses bricklayers' wages 1 - Other crafts' wages must be supplied, in B(16)
2	3-4	IC	City number (see Fig. 4.1). Format I2
	7-8	IS	Site number (not used by INDCEPT). Format I2

CONLAM input card description (continued)

Card No.	Column	Variable name	Description
3	11-12	IR	Region number (not used by INDCEPT). Format I2
	17-48	LOC	Location (alphabetic) (see Fig. 4.1). Format 8A4
	1-10	A(1)	Date (e.g., 1978.5). Format F10.2
	11-20	A(2)	Wholesale price index for steel mill products, Code 10-13 Steel Mill Products, "Monthly Labor Review," Bureau of Labor Statistics. Format F10.2
	21-30	A(3)	Hourly earnings index in the electrical equipment and supplies industry. Data from "Employment and Earnings," Bureau of Labor Statistics, SIC Code 36 Electrical Equipment and Supplies. The number has been normalized so that the index for 1967 is 100. This was done by multiplying the BLS data by 100/2.70. Format F10.2
	31-40	A(4)	Hourly earnings index in the steam engine and turbine industry. Data from "Employment and Earnings," BLS, SIC Code 3511 Steam Engines and Turbines. This has been normalized by multiplying the BLS number by 100/3.50 so that the index for 1967 is 100. Format F10.2
	41-50	A(5)	White collar wage index. Data from "National Survey of Professional, Administrative, Technical, and Clerical Pay," BLS. These data have been converted from a percent annual increase to an index based on 1967=100. Format F10.2

The following cards use a format of 8F10.2

4	1-10	B(1)	Hourly rate for building labor
	11-20	B(2)	Hourly rate for heavy construction labor

CONLAM input card description (continued)

Card No.	Column	Variable name	Description
5	21-30	B(3)	Hourly rate for bricklayers
	31-40	B(4)	Hourly rate for carpenters
	41-50	B(5)	Hourly rate for structural iron-workers
	51-60	B(6)	Hourly rate for plasterers
	61-70	B(7)	Hourly rate for electrical workers
	71-80	B(8)	Hourly rate for steamfitters
	1-10	B(9)	Hourly rate for operating engineers
	11-20	B(10)	Hourly rate for small tractor operators
	21-30	B(11)	Hourly rate for scraper operators
	31-40	B(12)	Hourly rate for crane operators
	41-50	B(13)	Hourly rate for air compressor operators
	51-60	B(14)	Hourly rate for truck drivers (<4 yd ³)
	61-70	B(15)	Hourly rate for boilermakers. Steamfitters' wages used
	71-80	B(16)	Hourly rate for all other crafts. Bricklayers' wages used
6	1-10	C(1)	Material costs for channels, dollars/100 lb
	11-20	C(2)	Material costs for I-beams, dollars/100 lb
	21-30	C(3)	Material costs for W-flanges, dollars/100 lb
	31-40	C(4)	Material costs for re-bars, dollars/100 lb
	41-50	C(5)	Material cost for 3000-psi Redimix concrete, dollars/yd ³
	51-60	C(6)	Material costs for 3/4-in. B-B plyform, dollars/1000 ft ²
	61-70	C(7)	Material costs for 2 x 4 fir or pine lumber, dollars/1000 bd ft
	71-80	C(8)	Land coefficient, Input 1000.00
7	1-80	C(9-16)	Unassigned

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