August, 1986

USER'S MANUAL

DRILTAC
(DRILLING TIME AND COST EVALUATION)

By

Resource Technology, Incorporated
4555 South Harvard Avenue
Tulsa, Oklahoma 74135
(918) 743-2985

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

This Work Was Supported By The U.S. Department of Energy,
Sandia National Laboratories,
Under Contract DE-AC04-76DP00789

TABLE OF CONTENTS

I.	THE PROGRAM	Page
A.	INTRODUCTION	1
B.	PROGRAM CONCEPT.	2
C.	OPERATION PROCEDURES	7
	Checking the DRILTAC Package For Completeness.	7
	Installing the Program	7
	Using Internal Routines.	10
	Running the DRILTAC Program.	20
II.	DATABASE A WELL DESIGN AND DRILLING INSTRUCTIONS	
	TABLE OF CONTENTS.	A-1
	FUNCTIONAL SPECIFICATIONS.	A-40
III.	DATABASE B OPERATION TIME AND COST DATA	
	TABLE OF CONTENTS.	B-1
	FUNCTIONAL SPECIFICATIONS.	B-49
IV.	DRILTAC DISPLAY AREAS	
	DATABASE A	
	WELL DESIGN AND DRILLING INSTRUCTION . .	C-1
	DATABASE B	
	OPERATION TIME AND COST DATA	C-1
	CALCULATION AREA 1	
	OPERATIONAL VARIABLE COST CALCULATION. .	C-8
	CALCULATION AREA 2	
	TIME AND COST ANALYSIS (Day Rate). . . .	C-11
	CALCULATION AREA 3	
	TIME AND COST ANALYSIS (Footage Rate). .	C-19
	CALCULATION AREA 4	
	INDIVIDUAL OPERATION	C-20

LIST OF TABLES AND TECHNICAL DATA

Table		Page
1.1 GEOLOGIC EVALUATION		
A-1	Geologic Formation Classifications Guide . .	A-3
1.2 WELL GEOMETRY		
A-2	Example Casing Programs Oil and Gas Wells. .	A-7
A-3	Example Casing Programs Geothermal Wells . .	A-8
1.3 CASING PROGRAM		
A-4	Casing Selection & Cost Guide.	A-11
1.5 RIG SELECTION		
A-5	Drilling Rig Selection	A-16
1.6 BIT PROGRAM		
A-6	Rotary Drilling Bit Selection & Cost	A-19
A-7	Diamond Drilling Bit Selection & Cost. . . .	A-20
A-8	Core Drilling Bit Selection & Cost	A-21
A-9	Bit Life	A-22
1.7 DRILLING FLUIDS PROGRAM		
●	Additives.	A-24
A-10	Surface Fluids System Volumes.	A-27
A-11	Additive Function.	A-28
A-12	Additive Application & Cost.	A-31
1.8 CEMENT PROGRAM		
A-13	Cement Costs	A-34
A-14	Oil Well Cement Classifications.	A-35
A-15	Additive Function.	A-36
A-16	Additive Costs and Mix Ratios.	A-37

Table		Page
	2.1 ROAD LOCATION AND SITE PREPARATION	
B-1	Road Location and Site Preparation Oper. Cost.	B-3
	2.2 INITIATION	
B-2	Initiation	B-4
	2.3 RIG MOVEMENT	
B-3	Rig Movement	B-6
	2.4 RIG OPERATING RATES	
B-4	Rig Operating Rates (Oil and Gas Drilling) . .	B-9
B-5	Rig Operating Rates (Geothermal Drilling). . .	B-10
	2.5 FUEL CONSUMPTION	
B-6	Fuel Consumption	B-12
	2.6 FUEL COST	
•	Fuel Cost.	B-13
	2.7 TRANSPORTATION AND MISCELLANEOUS COST	
B-7	Transportation and Miscellaneous Costs	B-14
	2.8 RENTAL COSTS	
B-8	Rental Costs	B-15
	2.9 SPECIAL TOOL COST	
B-9	Air Equipment.	B-17
B-10	Downhole Motors.	B-17
B-11	Deviation Subs and Tools	B-18
B-12	Telemetry Systems (MWD).	B-19

Table		Page
	2.10 SUPERVISION COST	
B-13	Supervision Cost	B-20
	2.11 CONDITION DRILLING FLUIDS	
●	Condition Drilling Fluid Time.	B-21
	2.12 WATER COST	
B-14	Water Cost	B-22
	2.13 BIT CHANGE	
●	Bit Change Time.	B-24
	2.14 BOTTOMHOLE ASSEMBLY (BHA) CHANGES	
●	Bottomhole Assemble Change Time.	B-25
	2.15 DRILLING PENETRATION RATES	
B-15	Drilling Penetration Rates	B-27
	2.16 REAMING OPERATIONS	
B-16	Reaming Operations Rate.	B-29
	2.17 PIPE HANDLING OPERATIONS	
B-17	Round Trip Time.	B-30
	2.18 AUXILIARY OPERATIONS - SURVEYING	
B-18	Surveying Operation Time	B-33
	2.19 AUXILIARY OPERATIONS - LOGGING	
B-19	Logging Operation Time and Cost.	B-35

Table

Page

2.21 CORING OPERATIONS

•	Core Barrel Lengths.	B-37
B-20	Round Trip Time.	B-38
•	Hourly Charges	B-39

2.22 CASING OPERATIONS

•	Operation Time	B-40
•	Tools, Services and Costs.	B-41

2.23 CEMENTING OPERATIONS

•	Operation Time	B-42
B-21	Tools and Service Costs.	B-43

2.24 WELLHEAD EQUIPMENT AND INSTALLATION

B-22	Wellhead Equip. Cost and Installation Data . .	B-46
------	--	------

LIST OF FIGURES

Figure		Page
	1.1 GEOLOGIC EVALUATION	
A-1	Generic Well Configuration Planning Diagram. .	A-4
	1.3 CASING PROGRAM	
A-2	Casing and Suggested Hole Size Chart	A-12
	1.7 DRILLING FLUIDS PROGRAM	
A-3	Example Drilling Fluid Costs	A-32
	2.24 WELLHEAD EQUIPMENT AND INSTALLATION	
B-1	Wellhead Assembly and Christmas Tree	B-45

I.

THE PROGRAM

A. INTRODUCTION

A number of computer programs have been developed to assist in the analysis of well design procedures. They relate to casing design, mud hydraulics, total well cost, etc. None, however, are available in the public domain that simultaneously evaluate the time and cost factors of the drilling equipment, the operational activities, the purchased components, and the inherent interrelationships of these elements. DRILTAC meets this need. This program is designed for use on a conventional personal computer (P.C.) with 640K of internal memory. It is easy to use and extremely versatile. The program utilizes LOTUS 1-2-3 for the program software. LOTUS 1-2-3 is a spreadsheet-type program that displays the traditional grid of columns and rows.

DRILTAC has the ability to develop and analyze a model of a hypothetical well and a model of the drilling system that will be used to drill the well. The program allows the user to change the geological environment of the well and the well design to any configuration desired. In addition, the user can change the various drilling parameters such as the mud program, the casing program, trip times, bottom hole assemblies, etc. Time and cost factors of every element of the drilling system and the drilling operation can also be changed as desired. Because of this flexibility, the program is extremely useful for testing the sensitivity of the total time and cost of drilling a well against individual system components, well design elements, or drilling operations time and/or cost change(s). Multiple changes can also be tested and evaluated by use of sensitivity analysis techniques.

B. PROGRAM CONCEPT

1. The Program

DRILTAC is a spreadsheet oriented program that allows the user to theoretically design and drill a well of any configuration, determine the total time and cost of drilling the well and then evaluate the incremental time and cost factors attributed to each element of the drilling operation and/or its associated drilling system components. The program is based on LOTUS 1-2-3 software and consists of two input data bases, and four calculation display areas. The input data bases consist of a well design file that allows the user to design any type of well, and an operations time and cost file that allows the user to input time and cost factors such as trip time and casing cost. The four calculation display areas are: 1) Operation Variable Cost Calculation, 2) Time and Cost Analysis, Day Rate, 3) Time and Cost Analysis, Footage Rate, 4) Individual Operation, Time and Cost Analysis. Varying the input data will change the calculation display area data, thereby allowing the operator to evaluate the effects on time and cost of changing the well design or the drilling operation. Application of sensitivity analysis techniques allows the evaluation and/or comparison of the effects of multiple changes and the time value involved.

2. Program Methodology

The designing of a well and the establishment of the drilling instructions can be divided into a series of functions. These functions, as noted in Figure 1, can be combined into a simplified logic diagram that displays the order in which each function must be accomplished, and the interrelationships involved.

As noted, the functions of geology (geologic understanding) and downhole equipment requirements are considered first and are combined to determine the casing program which in turn defines the well design. Having established this design, the drilling methods can then be determined. Drilling methods refers to the types of drilling procedures such as air drilling, mud drilling, coring, etc., that will be used to make hole. Bit programs, fluid programs, and cementing programs are determined next. Special drilling instructions such as bottom hole assembly changes, number of surveys and logging trips, and special tool requirements must also be defined.

WELL DESIGN AND DRILLING INSTRUCTIONS LOGIC DIAGRAM
(Abbreviated)

Figure 1

In reality, when all of the above functions have been completed, a drilling contract would normally be obtained, which in turn would define the type of rig used to drill the well. This contract would also establish day rates or footage rates, and other cost factors such as who pays for the pipe or the fuel. In this program, the type of rig, the payment schedule, other cost factors, etc., are selected by the program user.

The DRILTAC program allows the user to logically determine or perform all of the above functions, to vary the time and cost factors involved in each and to evaluate the resulting drilling program. DRILTAC performs the above operations by means of the logic design noted in Figure 2. This design requires the operator to input data of his choice into DATABASE A and B. This data is then combined in Calculation Area 1 to determine the individual variable cost increments associated with the different drilling operations. It also is combined in a special calculation area, into a series of equations that are used throughout the entire program. These equations automatically compute data such as depth drilled or trip time.

Values from DATABASE A and B, the variable cost data, and the special calculations, are then combined in the drilling program calculation area to determine the drilling program values. These calculations are then evaluated to develop the three remaining calculation display areas.

Because of the nature of the operating sequences, they can be combined into a computer spreadsheet program. LOTUS 1-2-3 software is used for this purpose. The spreadsheet is divided into seven main areas. DATABASE A defines the well design and the drilling instructions. It establishes the actual well configuration and casing program, the drilling techniques to be used, the bit program, the drilling fluids program and the cement program. It also defines the type of rig to be used and any auxiliary operations that may be required. The data required for Database A must be input by the model operator.

DRILTAC PROGRAM LOGIC DIAGRAM

Figure 2

DATABASE B incorporates the operation time and cost required by the various drilling and auxiliary operations. It includes transportation costs, rig operating rates, bit change time, etc. Some of this data is automatically entered by the computer program and some must be entered by the operator.

The input data for both DATABASE A and B can be obtained from Appendix A and/or B of this document. These Appendices define the requirements of each of the subsections in DATABASE A and B. They also provide numerous tables and charts from which the required data can be obtained.

Calculation areas 1, 2, 3 and 4 perform the necessary computations to determine the output displays of the program. Calculation area 1 displays the Variable Cost data. Calculation area 2 displays the time and cost factors associated with each drilling operation, and the cumulative time and cost as each operation takes place. These calculations are based on Day Rate costs. Calculation display 3 illustrates the time and cost of the drilling program in terms of a Footage Rate. Calculation area 4 displays the cumulative time and cost of each of the drilling operations, and certain key items such as total bit cost. The percent (%) of each of these costs with regard to the total cost is also shown.

- NOTE:
- DATA CAN ONLY BE ENTERED IN DATABASE A AND DATABASE B AND ONLY IN THOSE CELLS THAT ARE UNDERLINED.
 - IN CALCULATION AREAS 1 THROUGH 4 DATA WILL ONLY APPEAR IN THOSE CELLS NOT CONTAINING A DASHED LINE.

C. OPERATION PROCEDURES

DRILTAC is an easy program to use. The following sections will explain how the program operates and how to use it.

The program is designed for use on a conventional personal computer. Utilization of a hard disk is preferred, however 640K of internal memory is required. Use of LOTUS 1-2-3 is also required. Prior to using this program, it is suggested that the user familiarize himself with the personal computer, LOTUS 1-2-3, and the instructions that follow.

1. Checking the DRILTAC Package For Completeness

The DRILTAC Package, as received, contains the following components.

- DRILTAC Users Manual

The manual is a loose leaf binder. Review the manual. Check it against the Table of Contents, to be sure all parts are included.

- DRILTAC Program Package (2 Disks)

The DRILTAC Package consists of two disks.

DRILTAC - PRESET
DRILTAC - SEC1

2. Installing the Program

It is essential that DOS and LOTUS 1-2-3 be properly installed on your computer prior to loading DRILTAC. After checking to assure that they are installed, the operator can load the DRILTAC program. During this operation, the two DRILTAC disks will be combined into one file. Use the following procedure when installing DRILTAC for the first time or whenever reinstallation is necessary.

Note: Drive A: refers to the floppy disk drive.
Drive C: refers to the hard disk drive.

- a) Invoke LOTUS 1-2-3. To invoke LOTUS, you must be in the LOTUS environment. Depending on your particular computer system, this may involve changing directories or subdirectories. Before proceeding, the operator must be sure that he is accessing the area in which he wants the DRILTAC program stored.

INSERT: The LOTUS disk labeled 1-2-3 System Disk into Drive A and close the door latch.

RESPONSE: None.

ENTER: 123

RESPONSE: LOTUS will access the floppy drive, verify accessibility, and display the initial LOTUS screen.

PRESS: Any key to continue.

RESPONSE: LOTUS displays a blank spreadsheet.

REMOVE: The 1-2-3 System Disk from Drive A.

RESPONSE: None.

- b) Preset DRILTAC Parameters

Load the parameters for DRILTAC and the first half of the spreadsheet. The disk, DRILTAC-PRESET, is used to accomplish this task.

INSERT: The DRILTAC disk labeled DRILTAC-PRESET into Drive A and close the door latch.

RESPONSE: None.

TYPE: /FR (These key strokes instruct LOTUS to enter the File command level (/F) and Retrieve (R) a file.) Do not press the enter key.

RESPONSE: LOTUS will respond with the following request:
Enter the name of the file to retrieve:

ENTER: A:PRESET

RESPONSE: LOTUS will access Drive A, retrieve the file named PRESET, and display it on the screen.

REMOVE: The disk labeled DRILTAC-PRESET from Drive A.

RESPONSE: None.

*takes
several
minutes*

c) Combine DRILTAC Disks

DRILTAC is stored on two individual disks. The LOTUS "/File Combine" command is used to integrate these into one file. The cell pointer must be positioned exactly as stated below. Using the "Combine" command carelessly can invalidate the entire DRILTAC program. If there is any question concerning proper positioning, STOP, and begin this process again.

DEPRESS: The F5 key.

RESPONSE: Lotus will respond with the following request: Enter address to go to:

ENTER: BT1

RESPONSE: The cell pointer will be placed in cell BT1 at the top left hand corner of the spreadsheet.

INSERT: The DRILTAC disk labeled, DRILTAC-SEC1 into Drive A and close the door latch.

RESPONSE: None.

TYPE: /FCCE (These key strokes instruct LOTUS to enter the File command option (/F) using the Combine (C) option. It then instructs LOTUS to use the Copy (C) option and access the Entire (E) file.) Do not press the enter key.

RESPONSE: The following message will be displayed at the top of your screen:
Enter name of file to combine:

ENTER: A:SEC1 (This advises LOTUS to access the file in Drive A (A:) that has the name "SEC1".) IMPORTANT: Before depressing the enter key, be sure the cell pointer is in cell BT1.

RESPONSE: LOTUS will access Drive A, retrieve the file named SEC1, and display it on the screen.

REMOVE: The DRILTAC disk labeled DRILTAC-SEC1 from Drive A.

RESPONSE: None.

d) Save DRILTAC on Hard Disk

Having completed the "Combine Procedure", it is strongly suggested that DRILTAC be saved on the hard disk. This will eliminate the need to repeat this procedure everytime the program is used.

TYPE: /FS (This instructs LOTUS to enter the File command level (/F) and Save (S) a File.)
RESPONSE: LOTUS will respond with the following request:
Enter name of file to save:

ENTER: C:DRILTAC (Note: Do Not attempt to save DRILTAC to Drive A using the "Save" command.)
RESPONSE: LOTUS will make a complete copy of the DRILTAC Program in Drive C of the directory your are currently accessing.

3. Using Internal Routines

The user may now begin entering data into the DRILTAC program. It is suggested that the user familiarize himself with the following internal routines before proceeding. DRILTAC has six internal routines which are all controlled from a Main Menu. The purpose and operational procedure for each is outlined on the following pages.

ALT-M (Main Menu Routine)

Purpose: The Main Menu allows the user to access the internal routines available in the DRILTAC program.

Procedure:

DEPRESS: The "ALT" and "M" keys simultaneously.
RESPONSE: The DRILTAC program will respond by displaying the following menu screen:

Main Menu:

- C) Execute Clear Routine
- D) Execute Default Routine
- E) Execute Error Routine
- P) Execute Print Routine
- R) Execute Reload Routine
- S) Execute Save Routine
- T) Execute Text Routine

Enter the letter of the desired function;

ENTER: The menu selection of your choice.
RESPONSE: DRILTAC will respond differently depending on the letter of the function the user selects. Each option is defined on the following pages.

C (Clear Routine)

Purpose: When using LOTUS, the operator has the option of correcting individual cells of data or ranges of data. The Clear Routine, provided in DRILTAC, allows the operator to clear large sections of data in either DATABASE A or DATABASE B without having to provide LOTUS with the particular ranges. In DATABASE A, the Clear Routine will delete all data by zone. In DATABASE B, the Clear Routine allows the operator to delete all user inputs, default inputs or both. ✓

Procedure:

ENTER: C
RESPONSE: DRILTAC will display the following menu:

Clear Menu:

- A) Execute DATABASE A Options
- B) Execute DATABASE B Options
- C) Return to Main Menu

Enter the letter of the desired function;

ENTER: The menu selection of your choice.
RESPONSE: Depending on the option selected, DRILTAC will respond in the following manner:

Selection A. Enter A to delete DATABASE A inputs. DRILTAC will display the following menu:

DATABASE A Clear Options:

- A) Clear Zone A Inputs
- B) Clear Zone B Inputs
- C) Clear Zone C Inputs
- D) Clear Zone D Inputs
- E) Clear Zone E Inputs
- F) Clear Zone F Inputs
- G) Clear Zone G Inputs

H) Return to Clear Menu

Enter the letter of the desired function;

ENTER: The menu selection of your choice.

RESPONSE: Depending on the Zone selected above, DRILTAC will delete all user inputs from the selected area and return the user to this menu.

Selection B. Enter B to make DATABASE B deletions.
DRILTAC will display the menu illustrated below:

Note: User input values are those values that must be entered into DATABASE B by the program operator. Default values (see following section D Default Routine) are those values that are automatically entered into DATABASE B by the Default Routine.

DATABASE B Clear Options:

- A) Clear User Input Values
- B) Clear Default Input Values
- C) Clear All DATABASE B Input Values
- D) Return to Clear Menu

Enter the letter of the desired function;

ENTER: The menu selection of your choice.

RESPONSE: DRILTAC will delete the selected input values and return the user to the Clear Menu.

Selection C. Enter C when you have completed the deletion process and wish to return to the Main Menu.

- D (Default Routine)

Purpose: The default values are the suggested values listed throughout the DATABASE B document. The Default routine enters all values in DATABASE B that are dependent upon Classification Number (Section 1.1, DATABASE A) and Rig Selection (Section 1.5, DATABASE A). An average is substituted if more than one value is indicated in a table. This routine is designed to ease DATABASE B inputs. Use this routine only after DATABASE A inputs are complete.

Procedure:

ENTER: D

RESPONSE: DRILTAC first checks to determine if the user ran the Error Routine until no errors existed. If no errors are indicated, the Default Routine inserts the default values into the appropriate cells and returns the user to the top left cell of DATABASE B.

If an error exists, the following screen will be displayed and the Zone in question will be highlighted.

WARNING: Zone __ Error/Warning Exists
(Default values may not be VALID.)

- A) Display DATABASE A
- B) Display DATABASE B
- C) Display Error Screen
- D) Continue Default Routine

Enter the letter of the desired function;

The user has the option of continuing the Default Routine without making further changes to Database A inputs. This allows the user to exceed suggested input limits. DO NOT RUN the Default Routine if W25-Entry invalid for default is issued. Review E (Error Routine) below for corrective action.

Note: LOTUS will display 'ERR' in all default cells if Zone Classification and/or Rig Selection

is zero (0), negative, or an alphabetic character. To correct, change the values for Zone Classification and/or Rig Selection in DATABASE A and rerun the Default Routine.

- E (Error Routine)

Purpose: The Error Routine is designed to help the user validate DATABASE A input values. The routine is implemented one zone at a time. All input zones must be tested in order to guarantee output results.

Procedure:

SELECT: Option E.

RESPONSE: The DRILTAC program will display the following menu:

Error Menu:

- A) Verify Zone A
- B) Verify Zone B
- C) Verify Zone C
- D) Verify Zone D
- E) Verify Zone E
- F) Verify Zone F
- G) Verify Zone G

H) Return to Main Menu

Enter the letter of the desired function;

ENTER: The menu selection of your choice.

RESPONSE: The DRILTAC program will activate the Error Checking Routine and display the following screen:

DATABASE A. Error Validation Screen		
Line No.	Field Heading	Error/Warning Message

DRILTAC will edit the selected zone for input errors. As errors and/or warnings occur, the line number, field heading, and an error/warning number with a descriptive message will be displayed. This information is used in the following manner:

- a) Search the DATABASE A Functional Specifications Chart (Section II) for the corresponding line number and field heading.
- b) Find the matching error number.
- c) Analyze the input requirement.
- d) Make the necessary change in DATABASE A.
- e) Rerun the Error Check Routine until no errors occur.

Note: When a Warning occurs, the user is not required to change the input value. However, W25-Entry invalid for default MUST be corrected if you intend to use the Default Routine.

• P (Print Routine)

Purpose: The Print Routine allows the user to print various display areas of the DRILTAC program. Use this routine whenever a hard copy of the program inputs or outputs is desired. Illustrations of all DRILTAC display areas are noted in Section IV. of this manual.

Procedure:

SELECT: Option P.

RESPONSE: DRILTAC will display the following menu:

Print Menu:

- A) Print DATABASE A
- B) Print DATABASE B
- C) Print Calc Area 1
- D) Print Calc Area 2
- E) Print Calc Area 3
- F) Print Calc Area 4
- G) Print Error Screen
- H) Return to Main Menu

Enter the letter of the desired function;

ENTER: The menu selection of your choice.
RESPONSE: The Print Routine will print the selected display area. When the document has completed printing, the user will be returned to the Print Menu.

Note: When selecting option D (Print Calc Area 2), DRILTAC allows the user to choose which Zone Values to print. The following menu will be displayed:

Calc Area 2 Print Options:

- A) Print Zone A
- B) Print Zones A thru B
- C) Print Zones A thru C
- D) Print Zones A thru D
- E) Print Zones A thru E
- F) Print Zones A thru F

- G) Print All Zones

- H) Return to Main Menu

Enter the letter of the desired function;

ENTER: The menu selection of your choice.
RESPONSE: DRILTAC will print the indicated zone values plus the summation sheet at the end of DATABASE B. When the document has completed printing, the user will be returned to the Print Menu.

• R (Reload Routine)

Purpose: This procedure allows the user to reload the input data obtained from the Save Routine (See S Save Routine below). Use this procedure when you want to review previous input results.

Procedure: The Reload procedure uses the LOTUS "Combine" command. It is important to note that LOTUS overwrites current data when it combines a file. If you wish to save a copy of your current DRILTAC inputs, execute the Save Routine prior to retrieving a file. If you are retrieving a file from a floppy disk, insert it into Drive A before proceeding.

ENTER: R
RESPONSE: DRILTAC will respond by displaying the following menu:

Reload Menu:

- A) Reload from hard drive (Drive C)
- B) Reload from floppy drive (Drive A)
- C) Return to Main Menu

Enter the letter of the desired function;

ENTER: The menu selection of your choice.

RESPONSE: DRILTAC will return the user to the Main Menu if selection C is chosen. If option A or B is selected, DRILTAC will display the following menu:

Reload Options:

- A) Reload RUN1 values
- B) Reload RUN2 values
- C) Reload RUN3 values
- D) Reload RUN4 values
- E) Reload RUN5 values
- F) Reload RUN6 values
- G) Reload RUN7 values
- H) Return to Main Menu

Enter the letter of the desired function;

ENTER: The menu selection of your choice.

RESPONSE: LOTUS will access the indicated file from the previously selected drive and copy the values into the DRILTAC program. Remember, all current input values will be overwritten and lost if not properly saved prior to issuing this command.

DEPRESS: The 'F9' key.

RESPONSE: LOTUS will recalculate the program using the inserted values. This step is required since LOTUS is in manual calculation mode.

- S (Save Routine)

Purpose: The Save Routine is designed to allow the user to save input test values without having to store complete copies of the DRILTAC program. Use this routine when you want to store copies of your data on your hard or floppy disk. If you are saving a file to Drive A, insert the disk into the drive before proceeding.

Procedure:

ENTER: S

RESPONSE: DRILTAC will display the following menu:

Save Menu:

- A) Save input values to hard disk (Drive C)
- B) Save input values to floppy disk (Drive A)
- C) Return to Main Menu

Enter the letter of the desired function;

ENTER: The menu selection of your choice.

RESPONSE: DRILTAC will return the user to the Main Menu if selection C is chosen. If option A or B is selected, DRILTAC will display the following menu:

Save Options:

- A) Save RUN1 input values
- B) Save RUN2 input values
- C) Save RUN3 input values
- D) Save RUN4 input values
- E) Save RUN5 input values
- F) Save RUN6 input values
- G) Save RUN7 input values
- H) Return to Save Menu

Enter the letter of the desired function;

ENTER: The menu selection of your choice.
RESPONSE: DATABASE A and DATABASE B will be stored under the filename selected above. For example, if option C is selected, DRILTAC will store a file named RUN3 on the disk selected from the previous menu. This file will contain DATABASE A and DATABASE B values.

Note: If a file containing the selected filename already exists, LOTUS will require the user to CANCEL the save command or REPLACE the existing file with new the data. (The Save Routine does not make this decision.)

• T (Text Routine)

Purpose: The Text Routine allows the user easy access to the input and output display areas of the DRILTAC program.

Procedure:

SELECT: T
RESPONSE: The DRILTAC program will display the following menu screen:

Text Display Menu:

- A) Display DATABASE A
- B) Display DATABASE B
- C) Display Calc Area 1
- D) Display Calc Area 2
- E) Display Calc Area 3
- F) Display Calc Area 4
- G) Display Error Screen
- H) Return to Main Menu

Enter the letter of the desired function;

ENTER: The menu selection of your choice.
RESPONSE: DRILTAC will respond by placing the cursor in the upper left hand corner of the selected display area.

4. Running the DRILTAC Program

DRILTAC consists of two input areas; DATABASE A and DATABASE B. DATABASE A inputs are used to physically design the well. DATABASE B inputs describe the time and costs associated with those values selected in DATABASE A. The input process is defined on the following pages. To insure valid results, follow these procedures as outlined.

- a) Access the DRILTAC Program.
- b) Make DATABASE A inputs.
- c) Error Check DATABASE A inputs.
- d) Run DATABASE B Default Routine
- e) Complete DATABASE B inputs.
- f) Calculate the DRILTAC program.
- g) View DRILTAC results.

a) Access the DRILTAC Program

Once the DRILTAC program is stored on hard disk, it can be accessed by using the /File Retrieve command.

ENTER: The LOTUS program in the directory or sub-directory where you installed the DRILTAC program.

RESPONSE: LOTUS will display a blank spreadsheet.

TYPE: /FR (This command instructs LOTUS to R(etrieve) a F(ile))

RESPONSE: LOTUS will respond with the following request:
Enter name of file to retrieve:

ENTER: DRILTAC

RESPONSE: LOTUS will access the current drive and directory for the DRILTAC program and display the following program identification screen:

D R I L T A C
(Drilling Time and Cost Evaluation)

Prepared
by

Resource Technology, Incorporated
4555 South Harvard Avenue
Tulsa, Oklahoma 74135

This Work Was Supported By The U.S. Department of
Energy, Sandia National Laboratories, Under Contract
DE-AC04-76DP00789.

(Type ALT-M to continue)

b) Make DATABASE A inputs

Purpose: This step inputs data into the DATABASE A area of the program. DATABASE A values physically described the design of the test well.

Procedure: Data entry input requirements to the individual subsections of DATABASE A are discussed in the Section II. of this document. Use this information and the DATABASE A Functional Specifications Chart (Section II.) when making input decisions.

c) Error Check DATABASE A inputs

Purpose: This step validates DATABASE A inputs. The program checks for completeness, syntax, excessive values, and illegal values.

Procedure: To check DATABASE A inputs, select option E from the Main Menu. Each Zone must be error free before continuing. When errors occur, correct them and rerun the Error Routine. Use the Functional Specifications Chart as a correction guide. Warnings are informational to the user and may go uncorrected.

Note: W25-Entry invalid for default, must be corrected if the user intends to take advantage of the Default Routine.

d) Run DATABASE B Default Routine

Purpose: The Default Routine lessens the number of user inputs into DATABASE B. These values come

directly from the DATABASE B document. The user should view these values to determine if they are acceptable. The following list indicates the sections that will be filled with values if the default routine is invoked.

- 2.3 Rig Movement
 - 2.5 Fuel Consumption
 - 2.6 Fuel Cost
 - 2.7 Transportation and Misc. Cost
 - 2.8 Rental Cost
 - 2.10 Supervision Cost
 - 2.11 Condition Drilling Fluids
 - 2.12 Water Cost
 - 2.13 Bit Change
 - 2.14 Bottomhole Assembly (BHA) Change
 - 2.16 Reaming Operations
 - 2.17 Pipe Handling Operations
 - 2.18 Auxiliary Operations - Surv.
 - * 2.21 Coring Operations
 - * 2.22 Casing Operations
 - * 2.23 Cementing Operations
 - 2.24 Wellhead Equipment and Installation
- * - In Section 2.21, Core Barrel Length (Ft.), must be entered by the user. If Core Drilling - Conventional (cell D35) is selected in DATABASE A, enter the core barrel length in cell AB174. If Core Drilling - Wireline (cell D40) is selected in DATABASE A, enter a core barrel length in cell AB190. If both methods are selected, both values must be entered.
- In Sections 2.22 and 2.23, the user can enter values for 'Other'. These values are not required. They are intended to allow the user to include additional casing operation charges.

Procedure: To invoke the Default Routine, select option D from the Main Menu. (Do not use the Default Routine until all errors in DATABASE A are corrected. W25-Entry invalid for default, must be eliminated for this routine to properly execute.)

e) Complete DATABASE B inputs

Purpose: This step inputs data into the DATABASE B area of the program not covered by the DATABASE B Default Routine. DATABASE B inputs assign cost and time values to the drilling procedures selected in DATABASE A.

Procedure: Data entry input requirements to the individual subsections of DATABASE B are discussed in Section III. of this document. Use this information and the DATABASE B Functional Specifications Chart (Section III.) when making input decisions.

- 2.1 Road Location and Site Preparation
 - 2.2 Initiation
 - 2.4 Rig Operaton Rates
 - 2.9 Special Tool Cost
 - 2.15 Drilling Penetration Rates
 - 2.19 Auxiliary Operation - Logging
 - 2.20 Auxiliary Operation - Other
 - * 2.21 Coring Operations
 - * 2.22 Casing Operations
 - * 2.23 Cementing Operations
 - * 2.25 Maintenance and Drilling Problems
- * - In Section 2.21, Core Barrel Length (cell V174 and cell V190) are not entered by the Default Routine. These values are required if Core Drilling - Conventional (cell D35) or Core Drilling - Wireline (cell D40) are selected in DATABASE A.
- In Sections 2.22 and 2.23, the user can input values for 'Other'. These values are not required. The entries are intended to allow the user to include further casing operation costs.

f) Calculate the DRILTAC program

Purpose: LOTUS is in manual calculation mode. The user must calculate the program whenever input changes have been made. LOTUS informs the user when this is necessary by displaying 'CALC' at the bottom of the CRT screen

Procedure: Once all inputs (or changes) are complete, depress the F9 key. DRILTAC values will be calculated using the current inputs.

g) View DRILTAC Output Results

Purpose: DRILTAC contains four output areas.

Calc Area 1 - Operation Variable Cost Calculation (Day Rate)

Calculation area 1 summarizes by zone the operational variable costs.

Calc Area 2 - Time and Cost Analysis (Day Rate)

Calculation area 2 provides the user with a Time and Cost Analysis of the test well. The output is divided into the individual zone costs. Cumulative costs and time are also displayed.

Calc Area 3 - Time and Cost Analysis (Footage Rate)

Calculation area 3 provides the user with a zone by zone Time and Cost Analysis of the test well. Cumulative time and cost are displayed as well.

Calc Area 4 - Individual Operation (Time and Cost Analysis)

Calculation area 4 summarizes the operation time and cost of the individual drilling operations. Percentages of total time and cost are also provided.

Procedure: The output areas are viewed by using the Text Display Routine. If you wish to print a hard copy of the results, use the Print Routine. If you need to store the inputs for future use, use the Save Routine. The outputs are not stored but can be obtained by reloading the inputs and recalculating the program.

II.

DATABASE A

WELL DESIGN AND DRILLING INSTRUCTIONS

DATABASE A

TABLE OF CONTENTS

	Page
1.1 Geologic Evaluation	A-2
1.2 Well Geometry	A-5
1.3 Casing Program	A-9
1.4 Drlg. Techniques & Equipment Used	A-13
1.5 Rig Selection	A-15
1.6 Bit Program	A-17
1.7 Drilling Fluids Program	A-23
1.8 Cement Program	A-33
1.9 Auxiliary Operations	A-38
1.10 Bottomhole Assembly (BHA) Changes	A-39

1.1 GEOLOGIC EVALUATION

Definition

A thorough understanding of local geologic conditions is essential in designing a well and determining how to drill it. This knowledge assists in defining casing setting depths, determining bit selections, predicting adverse drilling conditions such as lost circulation or steeply dipping formations, etc. Proper definition and understanding of geologic conditions can strongly influence the total cost of the drilling operation.

Selection

A series of seven different geologic classifications is noted in Table A-1. These classifications are based on API Recommended Practice RP 7G, which is used for bit selection. They are, however, re-oriented so that they logically progress from very soft to extremely hard formations.

Data Entry Requirements

DRILTAC allows the user to design a well of any configuration desired. The well can be shallow or deep, and have up to seven casing strings or be completely open. The generic well model, Figure A-1, can be used as a guide for this design. It illustrates seven different zones. Each zone represents a different section of the well. It is not necessary to use all of these zones. Use only those that are necessary for the desired well design. However, a separate zone must be used for each casing string and/or the open hole section. Review sections 1.2 and 1.3 of this document before designing the well. It must also be noted that the uppermost section in Figure A-1 is designated "Initiation." Database B, Section 2.2, provides instructions for its design.

After determining the well configuration, a geological classification for only those zones used (excluding the "Initiation" section) must be chosen from Table A-1 and placed in the appropriate cell for each zone used on line 9. Only one classification per zone is allowed.

GEOLOGIC FORMATION CLASSIFICATIONS GUIDE

Table A-1

Classification Number	Formation Characteristics	Formation Type	API Bit Classification ⁽¹⁾ Series (Reference)
A-3	1 Very soft, very low compressive strength, high drillability.	Soft shale, clay, sand, salt.	1,4
	2 Soft, low compressive strength, high drillability.	Clay, red beds, sandstone, soft limestone, sandy shales, unconsolidated shales.	1,5
	3 Medium soft with low compressive strength.	Sandy shales, sands, unconsolidated shales.	2,5
	4 Medium, high compressive strength.	Shale, lime, sand, shaley lime.	2,6
	5 Medium hard, high compressive strength.	Dolomites, hard shales, hard limestone, hard sandy limestone.	2,6
	6 Hard, semi-abrasive, abrasive.	Quartz, chert, dolomite.	3,7
	7 Extremely hard, abrasive.	Granite, taconite, basalt.	8

Reference: (1) API - RP 7G

GENERIC WELL CONFIGURATION
PLANNING DIAGRAM

Note: Hole Depth (Ft.) - The distance (Ft.) from the surface to the bottom of a specific zone.

Figure A-1

1.2 WELL GEOMETRY

Definition

Well geometry defines the desired diameters and depths of the different zones of a well bore. Zone (hole) depth is defined as the distance (Ft.) from the surface to the bottom of the specific zone in question.

Well Design

The computer model allows the designing of a well with up to seven (7) different well bore diameters, casing and/or zone depths. The generic well model, Figure A-1, can be used to assist in determining the desired configuration.

Casing depths are normally determined by the need to isolate specific geologic zones or the need to stabilize the well bore wall. Well bore diameters are designed to insure sufficient clearance for cementing during casing operations, adequate hole cleaning for mud flow during drilling operations, etc. The internal diameter (I.D.) of the inner most casing is designed to allow sufficient clearance for the downhole production system.

As noted in Section 1.3, casing design starts with the inner most casing and works outward. After the inner most casing is chosen, a bit size is selected to drill a hole that compensates for the needs stated above. The internal diameter of the next outer casing string is then determined by selecting that casing size whose I.D. will allow clearance for the bit chosen above. This procedure is continued until all well bore sizes have been defined. Figure A-2 illustrates a series of compatible bit and casing dimensions. Considering the above comments, bore hole diameter is a function of casing design, bit diameter and required annular clearances. Thus it must be determined in conjunction with these factors. Examples of conventional well designs are noted in Tables A-2 and A-3.

In theory, the casing and/or liner should be run and set within a few inches of hole bottom. This is done to prevent damage to the casing in the event it slips or falls. In reality there is usually a greater distance because of the difficulty of being this accurate.

Data Entry Requirements

Using the generic well model, Figure A-1, as a guide, and the well design instruction noted in Sect. 1.1 Geologic Evaluation, Data Entry Requirements, determine the well configuration desired, and enter the desired hole (zone) depth (Ft.) and diameter (In.) in the appropriate cells for each zone used on lines 12 and 13.

EXAMPLE CASING PROGRAMS

OIL AND GAS WELLS

Table A-2

Area	Casing, in.	Hole size, in.	Depth, ft	Area	Casing, in.	Hole size, in.	Depth, ft	Area	Casing, in.	Hole size, in.	Depth, ft
Louisiana, land	20	26	1,000	West Texas, Pecos County	20	26	500	Mississippi-Alabama (a)	24	36	50
	13%	17½	4,000		13%	17½	2,000		13%	17½	2,500
	9%	12½	12,000		10%	12½	11,000		9%	12½	15,000
	7	8%	16,000 (liner)		7½*	9½	16,000 (liner)		7	8%	20,000 (liner)
	5	6½	20,000 (liner)		5**	6½	22,000 (liner)		5*	6½	22,000 (liner)
Louisiana, offshore	30 (driven)		800	*Tied back to surface				*Tied back with 5- and 7-in., and 4½-in. tied back to the 5-in. inside the 7-in.; 2½- and 2¼-in. tubing			
	20	26	1,200	**Tied back to top of 7½-in. liner; 4½-in. tubing into top of 5-in.				Mississippi-Alabama (b)	30	36	50
	13%	17½	4,000						20	26	2,000
	9%	12½	13,000	West Texas, Winkler County	20	26	1,000		14	17½	14,000
	7	8%	17,000 (liner)		13%	17½	6,000		10%	12½	20,000 (liner)
	5	6½	20,000 (liner)		10%	12½	12,500		7½	9½	22,000 (liner)
Texas Gulf Coast, South Texas Wilcox	20	26	1,000		7½*	9½	17,000 (liner)		5	6½	23,000 (liner)
	13%	17½	9,000		5	6½	22,000 (liner)				
	9%	12½	12,000	*Tied back to surface; 3½-in. tubing into top of 5-in.				(Note: The deep Mississippi-Alabama wells have a complex liner tie-back arrangement. The reader is referred to the reference for further information. "Deep Mississippi Methods Extend Drilling Frontier," by Erich F. Klemetick, Petroleum Engineer, March 1977, pp. 70-84.)			
	7	8%	14,000 (liner)	Oklahoma, Caddo County	20	26	70	Utah, Uinta County (a)	18	26	100
	5	6½	16,000 (liner)		13%	17½	3,000		9%	12½	2,500
Texas Gulf Coast, Upper Wilcox	20	26	1,000		10%	12½	16,000		7	8%	13,000
	10%	17½	4,000		8%	9½	20,400 (liner)		5	6½	17,000 (liner)
	7½	9½	12,000		4½	7½	23,200 (liner)	Utah, Uinta County (b)	20	30	500
	5½	6½	18,000 (liner)	Oklahoma, Roger Mills County (a)	20	26	100		13%	17½	8,500
West Texas, Wheeler County	20	26	450		13%	17½	4,500		9%	12½	15,000
	13%	17½	5,400		10%	12½	15,500		7	8%	21,000
	9%	12½	18,000		7%	9½	18,000 (liner)	Wyoming, Park	20	30	100
	7*	8½	23,000 (liner)		5	6½	23,300 (liner)		13%	17½	3,000
*Tied back with 5-in. tubing				Oklahoma, Roger Mills County (b)	30	36	100		9%	12½	7,100
West Texas, Hemphill County	20	24	400		20	26	300		7	8½	21,000
	13%	17½	4,200		13%	17½	5,000		4½	6	23,000 (liner)
	9%	12½	14,000		9%	12½	14,800	Wyoming, Fremont County (a)	20	30	2,000
	7	8%	17,400 (liner)		7½*	8½	18,000 (liner)		13%	17½	7,000
	4½	6½	21,000 (liner)		5	6½	22,000 (liner)		10%	12½	16,000
West Texas, Ward County	20	26	1,500	*Tied back to surface with 7-in.					7½	9½	19,000
	13%	17½	5,000	Oklahoma, Washita County	30	36	250	Wyoming, Fremont County (b)	20	30	—
	9%	12½	12,000		20	26	4,500		13%	17½	4,000
	7½*	8½	14,000 (liner)		14	17½	14,500		9%	12½	15,000
	5**	6½	20,000 (liner)		9%	12½	22,000	Wyoming, Natona	20	30	500
*Tie back with 7-in. to surface					8%	7½	25,800 (liner)		13%	17½	5,000
**Tie back with 5-in. to top of 7½-in. liner; 4½-in. X 3½-in. tubing from top of 5-in. to surface.				Mississippi, Smackover (a)	13%	17½	1,000		9%	12½	14,000
West Texas, Reeves County	20	26	1,000		9%	12½	3,000		7	8½	19,000 (liner)
	13%	17½	5,000		5½	7½	17,000		5½	6½	22,000 (liner)
	9%	12½	12,000	Mississippi, Smackover (b)	16	20	1,000				
	7½*	8½	16,000 (liner)		10%	15	4,000				
	5**	6½	21,000 (liner)		7%	9½	16,000				
*Tie back with 7-in. to surface					5½	6½	17,000 (liner)				
**Tie back with 5-in. to top of 7½-in. liner; 4½-in. tubing from top of 5-in. to surface.											

Reference: Short, J.A., Drilling and Casing Operations, PennWell Publishing Co., 1982, pp. 340-342.

EXAMPLE CASING PROGRAMS

GEOHERMAL WELLS

Table A-3

Area	Casing, in.	Hole size, in.	Depth, ft.	Area	Casing, in.	Hole size, in.	Depth, ft.
California, Brawley	20	26	100	Idaho, Raft River, #1	30	42	40
	13 3/8	17 1/2	1400		20	26	901
	9 5/8	12 1/4	4000 (liner)		13 3/8	17 1/2	3623
	7	8 1/2	6000 (liner)			8 3/4	5006 (openhole)
California, East Mesa, #8-1	20	26	60	New Mexico, BACA, #17	30	36	50
	13 3/8	17 1/2	998		20	26	247
	7 5/8	12 1/4	4946 (liner)		13 3/8	17 1/2	1173
	7 5/8	8 1/2	6002 (slotted)		9 5/8	12 1/4	3000 (liner)
		6 1/2	6205 (openhole)		7	8 3/4	6254 (liner)
California, Geysers	26	30	50	Utah, Roosevelt Hot Springs, #14-2	20	26	79
	20	26	300		13 3/8	17 1/2	645
	13 3/8	17 1/2	2500		9 5/8	12 1/4	1805
	9 5/8	12 1/4	5500 (liner)			8 1/2	6100 (openhole)
		8 3/4	8000 (openhole)				
California, Westmoreland	20	26	100				
	13 3/8	17 1/2	2000				
	9 5/8	12 1/4	8000				
	7	8 1/2	11000 (hangoff)				

1.3 CASING PROGRAM

Definition

Casing consists of a series of steel pipes either welded or screwed together to form a long steel tube. These tubes are placed in the well bore to stabilize the well bore wall, to isolate various geologic zones, and to form a platform to which the surface pressure control or well head equipment can be attached. The term "casing" is usually applied to those lengths of pipe that extend from the surface down to a specified depth. Those lengths of casing that do not originate at the surface but do extend to specified depths are called "liners". The casing program defines the types and lengths of casing and liners used in the well.

Selection

Casing and liner pipe is available in numerous sizes as noted in Table A-4. These sizes conform to API specifications.

When selecting casing, one must first define the depths at which the casing will be set and cemented. This is primarily based upon formation characteristics, hole problems, and local government regulations. The casing diameters are then chosen based upon bit clearances in the casing, casing stresses, and the diameter of the casing at the bottom of the hole which will allow economic production of the pay zone. Casing programs are designed from the inner string to the outer string, and from the bottom of the hole to the top of the hole. Figure A-2 notes suggested bit-casing selection combinations and Tables A-2 and A-3 list a series of typical casing programs used for different applications in different sections of the country. It should be noted that geothermal wells tend to require larger diameter casing programs than oil or gas wells. This is due to the high volume, production fluid flow through the casing and the ensuing reduction of friction and pressure loss when using large diameter pipe.

Cost

The cost of casing varies, depending upon the grade of steel used and the dimensions (weight) required. Unit costs (\$/100 Ft.) are noted in Table A-4.

Data Entry Requirements

Using Table A-4 and Figure A-1 as a guide, determine the length (Ft.) and diameter (In.) of the casing desired and enter the data in the appropriate cells for each zone used on lines 16 and 17. Having selected the type of casing desired, unit cost of the casing can be obtained from Table A-4. Enter the unit cost (\$/100 Ft.) in the appropriate cell for each zone used on line 18.

CASING SELECTION & COST GUIDE

Table A-4

Dimensions					Min. Yield Strength (000 lbs.)	T & C End Finish	Unit ⁽²⁾ Cost (\$/100')
Size ⁽¹⁾ O.D. (In.)	Steel Grade	Wall Thickness (In.)	Internal Diameter (In.)	Weight per ft. (lbs.)			
4 1/2	K-55	.205	4.090	9.50	111	Short	553
4 1/2	K-55	.224	4.052	10.50	165	Short	647
4 1/2	N-80	.290	3.920	13.50	307	Long	966
5	K-55	.253	4.494	13.00	208	Short	718
5	N-80	.362	4.276	18.00	422	Long	1247
5 1/2	K-55	.244	5.012	14.00	161	Short	741
5 1/2	K-55	.275	4.950	15.00	248	Long	828
5 1/2	N-80	.361	4.778	20.00	466	Long	1337
7	H-40	.272	6.456	20.00	230	Short	1029
7	K-55	.317	6.366	23.00	366	Long	1253
7	N-80	.453	6.094	32.00	745	Long	2138
7 5/8	H-40	.300	7.025	24.00	276	Short	1238
7 5/8	K-55	.328	6.969	26.40	414	Long	1438
7 5/8	N-80	.430	6.765	33.70	778	Long	2274
9 5/8	H-40	.312	9.001	32.30	365	Short	1562
9 5/8	K-55	.395	8.835	40.00	630	Long	2000
9 5/8	N-80	.472	8.681	47.00	1086	Long	3014
10 3/4	H-40	.350	10.192	32.75	367	Short	1892
10 3/4	K-55	.400	9.950	45.50	715	Short	2135
10 3/4	N-80	.495	9.760	55.50	1276	Short	3098
13 3/8	H-40	.330	12.715	48	541	Short	2343
13 3/8	K-55	.430	12.515	61	962	Short	2593
13 3/8	N-80	.514	12.347	72	1661	Short	4499
20	K-55	.812	18.376	169	---	---	5200
30	Line Pipe	.438	29.124	138	---	---	7500
36	Line Pipe	.438	35.124	166	---	---	9000

Reference: Manufacturers' Literature, 1985.

Notes: (1) The size (O.D.) of casing shown are examples of sizes available. For a complete list, see API Specs 5A, 5AC, 5AQ, 5AX.

(2) Prices shown are Vendor list prices and do not include discounts. As of July, 1985, discounts of 30 to 35% were available. Discounts should be considered.

CASING AND SUGGESTED HOLE SIZE CHART

Figure A-2

Note: Solid line — indicates commonly used combination.
Dashed line --- indicates less commonly used combination.

Reference: Greenip, J.F., "Tubulars Isolate Down-hole Pressures", Oil and Gas Journal, October 9, 1978, pp. 83-92.

1.4 DRILLING TECHNIQUES & EQUIPMENT USED

Definition

Drilling techniques & equipment used, refers to the drilling method used to drill the well, and the required auxiliary equipment. Coring operations are included in this category because they do, in fact, make hole. Reaming is also included as it is a technique used to enlarge the hole, even though it does not deepen the hole.

Selection

Three drilling techniques are considered. They are:

- Rotary Drilling - Air
- Rotary Drilling - Mud
- Downhole Motor - Mud

Two coring operation techniques are also considered. They are:

- Core Drilling - Conventional
- Core Drilling - Wireline

A sixth category, "Other", is included to allow the use of one other, non-identified, hole-making method that may be considered.

The model allows the user to select any combination of drilling methods desired. The user determines the percentage of drilling time each technique will be used in each zone. It is important to note that the total of the percentages of drilling time of the various drilling techniques used in each zone must equal 100%.

Under each technique, a series of auxiliary components is listed that may or may not be used with that method. The user determines the components required, and the percentage of time each component is used with the specific method in each zone. For example; Rotary Drilling-Air, may be used only 40% of the time in Zone C, however, during that specific air drilling operation, air compressors and air hammers will each be used 100% of the time. The term "Other" refers to any other type of equipment required but not listed.

Reaming is primarily used to widen the hole diameter to the bit, full gauge diameter. It is also used to clear out keysets or doglegs.

Data Entry Requirements

Determine the drilling method or methods used in each zone, and enter the percentage (%) of time each is used in the appropriate cells in each zone on lines (22,27,30,35,40,45). The total of the percentages of method use in each zone must equal 100%.

After the drilling methods have been selected, determine the auxiliary components required for each specific method, and enter the percentage (%) of time each component is used with each method, in the appropriate cell in each zone. The total of the percentages of the time of use of auxiliary components for each drilling method in each zone does not have to equal 100%.

Determine the number of feet (Ft.) that must be reamed in each zone of the well bore and enter this data in the appropriate cell for each zone on line 46.

After the above determinations have been made and the data entered into the appropriate cells, do not enter any other data in any cell in section 1.4.

Note: The percentage numbers entered into the cells stated above must be in the form of whole numbers such as 26, 100, 30 etc. Do not use a decimal such as .26 or .30.

1.5 RIG SELECTION

Definition

The drilling rig is the basic equipment system used for drilling a well. It normally consists of a mast and substructure, the hoisting system, the mud system, the power system, the rotating system, the blow out preventer system, controls and auxiliary components.

Selection

Rig selection is primarily accomplished by choosing a rig that can, in a cost efficient manner, handle the anticipated loads involved in drilling the well, and provide sufficient hydraulic capacity to properly clean the bottom of the hole and circulate out the cuttings. Other factors to be considered are the rig crew capability, rig condition, rig-site conditions and rig design.

Six rig classifications are noted in Table A-5. Estimated drilling depth capability and representative drilling rig components are noted for each classification.

Data Entry Requirements

Select the drilling rig desired and enter the rig class number in the cell for Zone A on line 48. The model program will then automatically assume that this rig is used to drill all zones. Only one rig can be chosen for each drilling program.

DRILLING RIG SELECTION

Table A-5

Rig Classification		Representative Rig Equipment									Comments
		Drilling Equip.		Mud Pumps			Primary Power				
Class	Estimated Drilling Depth Rating (Ft.)	Rig Manufacturer	Model No.	Pump Manufacturer	Model No.	No. Units	Engine Manufacturer	Model No.	No. Units	Total Continuous H.P.	
A-16	1	Cooper	LTO-750				Det. Diesel	8V71-N	2	466	Truck Mounted Rig
	2	Mid Continent	U-712-EA	Gar. Denv	PZ-9	2	Caterpillar	D379	3	1,680	
	3	Nat. Supply	110-UE	Nat. Supply	10-P-130	2	Caterpillar	D398	3	2,250	
	4	Nat. Supply	1320-UE	Nat. Supply	12-P-160	2	Caterpillar	D399	3	3,000	
	5	PARCO		Con. Emsco	FB 1600	2	Waukesha	5792	3	3,600	Parker, Rig No. 182
	6	50,000	PARCO		Con. Emsco	FB 1600	3	Waukesha	6670	4	6,000

1.6 BIT PROGRAM

Definition

The bit program constitutes the selection of the bits that will be used to drill the various sections (zones) of the hole.

Selection

Bit selection is based on using those bits that provide the most economical drilling. Quite often high penetration rate or achieving ultimate bit usage are detrimental to achieving this goal. Factors that should be considered are the type of formation being drilled, offset bit records, good drilling practices, weight on bit, bit RPM, mud program, and a clear understanding of the interrelationships of these characteristics. This information can then be economically analyzed for best bit performance.

In drilling operations four different types of bits are normally used. They are the steel tooth bit, the tungsten carbide insert bit, the polycrystalline diamond bit, and the conventional diamond bit. The steel tooth bits are the least expensive and are best used in soft or medium formations. The tungsten carbide insert bits are more expensive but have longer life than the steel tooth bit. These bits are normally used in medium or hard formations. Polycrystalline diamond bits (PDC) are the most expensive but have a longer life. They normally are used in soft or medium formations, or with downhole motors. Diamond bits are also expensive and are normally used in hard formations. If properly used they can achieve long drilling runs with the accompanying economic benefits. It should be noted that within the steel tooth bit and tungsten carbide insert bit groups there is a category of bits that is better suited for deviation control. This control is achieved by the pre-set, offset angle of the roller cones.

When coring, two different types of operations must be considered. They are conventional coring and wireline coring. Conventional coring primarily uses diamond, surface set bits. This type of bit is used for most oil field applications. Wireline coring uses either surface set or diamond impregnated bits. Both can be used effectively in soft to ultra hard

formations. Diamond impregnated bits will, however, last longer because of their inherent design characteristics.

Data Entry Requirements

Considering the type (classification) of rock being drilled in each zone as noted in Section 1.1, line 9, the diameter of the hole being drilled in each zone as noted in Section 1.2, line 13, and the type of drilling technique used to drill each zone as noted in Section 1.4, lines 22, 27, 30, 35, 40, and 45, select the desired bits and their corresponding costs (\$/Bit) from Table A-6 and enter this data in the appropriate cells for the selected drilling techniques specified for each zone. Bit selection is reference information only and can be omitted if desired. However, bit cost data must be entered.

Having selected the types of bits, and again considering rock classifications, select the appropriate bit life data (Avg. Hrs.) from Table A-9. Enter this data in the appropriate cells for the selected drilling techniques specified for each zone.

ROTARY DRILLING BIT SELECTION & COST

Table A-6

Steel Tooth Bits ⁽¹⁾								
Bit Size (In.)	Non-Sealed Roller Bearing		Sealed Roller Bearing		Sealed Journal Bearing		Deviation Control	
	Jet (\$)	Gauge Prot. (\$)	Jet (\$)	Gauge Prot. (\$)	Jet (\$)	Gauge Prot. (\$)	Non Sealed (\$)	Sealed (\$)
6 1/8	751				1123			
6 1/2	826				1163			
7 7/8	944	1149	1158	1365	1238	1422	1190	1744
8 3/4	1030	1252	1302	1534	1393	1598	1324	1878
9 1/2	1226	1491	1725	2033	1845	2118	1721	
12 1/4	1749	2129	2311	2847	2472	2966	2629	3089
14 3/4	3011	3663			4370			5457
17 1/2	4945	5917	7038	8079				
26	12930							
36								
42								
Tungsten Carbide Insert Bits ⁽²⁾								
Bit Size (In.)	Non-Sealed Roller Bearing		Sealed Roller Bearing		Sealed Journal Bearing		Deviation Control	
		(\$)		(\$)		(\$)	Roll. Bear (\$)	Jour. Bear. (\$)
6								
6 1/2		2711				3374		
7 7/8		3029		3354		3752	4026	4469
8 3/4		3413		3865		4345	4911	
9 1/2		3741		4587		5557		
12 1/4		5772		7057		8420		9262
14 3/4		8046		11187		13358	14358	
17 1/2		11794		14735		17432		

Note: (1) - Good for drilling formations in Geol. Class No. 1 through 6.

(2) - Good for drilling formations in Geol. Class No. 1 through 7.

DIAMOND DRILLING BIT SELECTION AND COST

Table A-7

Diamond Drilling Bits		
Bit Size (In.)	Bit Cost (\$) (1) (2) (3)	
	Rotary Drlg.	D.H. Motor Drlg.
6 1/4	8,000	6,000
6 3/4	9,100	7,200
7 7/8	12,400	9,500
8 3/4	15,900	11,150
9 7/8	18,000	13,200
12 1/4	25,000	18,000
17 1/2	57,300	45,400

PDC Bits	
Bit Size (In.)	Bit Cost (1) (4) (\$)
6 1/4	11,500
6 3/4	12,100
7 7/8	14,700
8 3/4	16,800
9 7/8	21,500
12 1/4	28,000
17 1/2	54,800

- Note:
- (1) Prices do not include deposits.
 - (2) Prices will vary based on number of stones/carats used and upon the specific bit design.
 - (3) Good for drilling formations in Geol. Class. No. 1 through 7.
 - (4) Good for drilling formations in Geol. Class. 1 through 5.

CORE DRILLING BIT SELECTION & COST
Table A-8

Bit Cost (\$)							
Bit Size (In.)	Geologic Classification Number						
	1	2	3	4	5	6	7
Conventional Natural Diamond Coring Bits (Conventional Coring)							
4 1/8 - 4 5/8		3,500	3,500	3,600	3,600	4,000	
5 3/4 - 6 3/4		5,000	5,000	5,500	5,500	5,700	
6 1/4 - 6 3/4		5,600	5,600	6,000	6,000	6,100	
6 1/4 - 7 7/8		6,000	6,000	7,000	7,000	8,000	
7 7/8 - 8 3/4		7,800	7,800	9,000	9,000	9,100	
9 7/8 - 12 1/4		12,700	12,700	13,200	13,200	13,700	
Surface Set Diamond Coring Bits (Wireline Coring)							
1.89			190	190	195	210	
2.36			250	250	230	260	
2.98			375	375	370	430	
3.65			650	520	500	600	
4.83			1,000	1,300	1,000	1,100	
Diamond Impregnated Coring Bits (Wireline Coring)							
1.89				250	250	250	250
2.36				370	360	350	350
2.98				525	525	475	475
3.65				710	710	675	675
4.83				1,400	1,400	1,200	1,200

BIT LIFE (1)
(Estimated Hrs.)

Table A-9

Bit Type	Geologic Classification Number (2)						
	1	2	3	4	5	6	7
Drilling:							
Steel Tooth	30 - 50	20 - 40	15 - 35	15 - 30	10 - 20	5 - 15	5 - 10
Tungsten Carbide Insert	40 - 100	30 - 90	25 - 75	20 - 60	20 - 55	15 - 50	15 - 40
PDC	50 - 150	45 - 100	30 - 75	20 - 50	10 - 30		
Diamond	40 - 120	40 - 100	35 - 85	30 - 75	25 - 60	20 - 50	20 - 50
Coring:							
Conventional Natural Diamond		10 - 20	10 - 20	7 - 17	7 - 17	5 - 15	5 - 15
Surface Set Diamond		15 - 30	15 - 25	12 - 22	12 - 22	10 - 20	10 - 20
Diamond Impregnated		40 - 60	40 - 60	38 - 58	37 - 55	36 - 52	35 - 50

Note: (1) Bit life is estimated, and can vary widely.

(2) Geologic Classification numbers correspond to those noted in Table A-1, Section 1.1. For reference purposes:

- Class 1 - Soft shale, clay, sand, salt.
- Class 2 - Clay, red beds, sandstone, soft limestone, sandy shale, unconsolidated shales.
- Class 3 - Sandy shales, sand, unconsolidated shales.
- Class 4 - Shale, lime sand, shaley lime.
- Class 5 - Dolomites, hard shale, hard limestone, hard sandy limestone.
- Class 6 - Quartz, chert, dolomite.
- Class 7 - Granite, tacomite, basalt.

1.7 DRILLING FLUIDS PROGRAM

Definition

Drilling fluids are liquid mixtures or gases used in the drilling operation to clean out the bottom of the hole and carry the cuttings to the surface, control bottomhole pressures, cool the bit, and maintain hole stability. Drilling fluids also effect cutting rates, torque values, reduction of corrosion, etc. The drilling fluids program defines the types of fluids and when they are to be used.

Selection

Defining a drilling fluids program is a fairly complicated procedure. In this model three areas are considered.

1. Surface Fluids System Build Up
2. Additional Volume
3. Daily Maintenance

The first is the build up of the surface fluids system prior to the start of the drilling program. It includes the obtaining and cost of the water (defined in other sections of the program), and the oil and/or the additives required to make up the initial volume of drilling fluid. This fluid is mixed and stored in the mud tanks.

Additional volume is the volume of fluid that must be added to the fluid system to provide for the fluid needed to fill up the well bore as it is being drilled in each zone.

Daily maintenance is the volume of fluid that must be added daily to the fluid system to compensate for losses due to spillage, geologic absorption, etc.

In the first two areas, both additive type and cost is considered. In the third area, only cost is considered.

A. Additives

The main classifications ⁽¹⁾ of drilling fluids are water-base systems, oil-base systems and air, gas, mist or foam systems.

1. Water-base Systems (Water is the continuous phase)

• Low pH

Fresh Water: Those having a liquid phase of water containing only small concentrations of salt, with a pH ranging from 7 to 9.5. This would include spud muds, bentonite treated muds, red muds, organic colloid treatments and some completion fluids.

Brackish Water: Includes 7 to 9.5 pH sea and brackish, or hard, water fluids. Source water may be from open sea or bays.

Saturated Saltwater: Liquid phase of this system is saturated with sodium chloride, although other salts may be present. These may be prepared from fresh water or brine.

Gyp Treated: The gypsum treated or gyp-base muds are formulated by conditioning the mud with commercial calcium sulfate.

• High pH

Lime Treated: Consists of adding caustic soda, lime, clay and organic thinner. These normally have a pH greater than 11.

Fresh Water: Fluids having a liquid phase of water, treated to bring the pH level above 9. These would include most alkaline-tannant treated muds, etc.

2. Oil-base Systems (Oil is the continuous phase and water is the dispersed phase)

Invert Emulsion Muds: These water-in-oil muds have water as the dispersed phase and oil as the continuous phase. They may contain up to 50% water by volume in the liquid phase.

(1) Reference: "Guide to Drilling, Completion and Workover Fluids", World Oil, June 1985, p. 57.

Oil Muds or Oil Base Muds: Both are included in this mud system category. IADC identifies oil muds as, "usually a mixture of diesel fuel and asphalt; not emulsions at the start of their use in drilling. Viscosity is controlled by the addition of diesel fuel to thin, and asphalt compounds or organo clays to thicken. Weight is increased by the addition of barites. As a rule, oil muds will either form w/o emulsions with formation water or from other sources of water contamination." API, in Bulletin D11, defines oil-base mud as "a special type drilling fluid where oil is the continuous phase and water the dispersed phase. Oil-base mud contains blown asphalt and usually 1 to 5% water emulsified into the system with caustic soda or quick lime and an organic acid. Oil-base muds are differentiated from invert emulsion muds (both water-in-oil emulsions) by the amounts of water used, method of controlling viscosity and thixotropic properties, wall-building materials and fluid loss."

3. Air, Gas, Mist, Foam Systems

Air Gas, Mist, Foam: These include aerated and gaseated systems.

Water base systems are the most commonly used fluids. Oil base systems are more expensive and are generally used in higher temperature applications, water sensitive zones, production zones, and in certain types of fishing jobs. Air, gas, mist or foam systems are the best systems to use because of the high drilling rates that can be obtained, the reduction of lost circulation problems, the low viscosities and densities, etc. However, these systems cannot provide hole control, lubricity, etc. Thus, they are limited in use.

Various additives are used to develop the different systems stated above. Types of additives and their functions are noted in Table A-11.

B. Cost

The cost of the drilling fluids program is based upon the type and volume of additives used. Because of the variability in types and volumes of additives, the

total drilling fluids cost can vary sharply from one well to another. Examples of these variations are noted in Figure A-3.

It should be noted that the program will provide a fairly accurate (70-90%) cost calculation. A more accurate cost estimate is quite difficult to obtain because of the difficulty of predicting the additive volumes of fluids required for daily maintenance, and predicting the drilling problems that will be encountered.

Data Entry Requirements

Considering the rig classification determined in Section 1.5, line 48, select the appropriate surface fluids system volume from Table A-10 and enter this data only in cell Zone A, line 78. The types of additives required are determined from Tables A-11 and A-12 and can be placed in cell Zone A, line 79. This data is reference information only and can be omitted if desired. The total unit costs (\$/100 BBLs.) of these additives (the total cost of additives per 100 barrels of surface system fluid) can be determined from Table A-12 and must be placed only in cell Zone A, line 80.

With regard to additional volume, evaluate Tables A-11 and A-12 and choose the desired additives for each zone. Place this data in the appropriate cell for each zone on line 82. This data is reference information only and can be omitted if desired. The total unit cost (\$/100 BBLs.) of the additives for each zone can be determined from Table A-12 and must be placed in the appropriate cell for each zone on line 83.

Daily maintenance cost will vary sharply as noted in Figure A-3. However, an average cost of \$1500/day may be desirable to use. This value (or any other appropriate value) must be entered in the appropriate cell for each zone on line 85.

SURFACE FLUIDS SYSTEM VOLUMES

Table A-10

Rig Classification		Approximate Fluid Volume (bbls)
Class	Est. Drlg. Depth Rating (Ft.)	
1	8,000	300
2	12,000	400
3	16,000	500
4	20,000	1,000
5	30,000	1,800
6	50,000	3,000

ADDITIVE FUNCTION⁽¹⁾

Table A-11

Alkalinity, pH Control Additives: Products designed to control the degree of acidity or alkalinity of a fluid. These can include lime, caustic soda and bicarbonate of soda.

Bactericides: Used to reduce bacteria count. Paraformaldehyde, caustic soda, lime and starch preservatives are commonly used.

Calcium Removers: Caustic soda, soda ash, bicarbonate of soda and certain polyphosphates make up the majority of chemicals designed to prevent and overcome the contaminating effects of anhydrite and gypsum, both forms of calcium sulfates, which can wreck the effectiveness of nearly any chemically treated fluid not employing calcium removers.

Corrosion Inhibitors: Hydrated lime and amine salts are often added in systems to check corrosion. A good fluid containing an adequate percentage of colloids, certain emulsion muds and oil muds should exhibit excellent corrosion inhibiting properties.

Defoamers: Products designed to reduce foaming action, particularly in brackish and saturated saltwater muds.

Emulsifiers: For creating a heterogeneous mixture of two liquids. These include modified lignosulfonates, certain surface active agents, anionic and non-ionic (negatively charged and non-charged) products.

Filtrate Reducers: Filtrate, or fluid loss reducers—such as bentonite clay, CMC (sodium carboxymethylcellulose) and pregelatinized starch serve to cut filter loss, a measure of the tendency of the liquid phase of the drilling fluid to pass into the formation.

Reference: "Guide to Drilling, Completion and Workover Fluids", World Oil, June 1985, p. 57-58.

Flocculants: These are sometimes used to raise gel strength. Salt (or brine), hydrated lime, gypsum and sodium tetraphosphates may be used to cause colloidal particles in suspension to group into bunches, or "flocs," causing solids to settle out.

Foaming Agents: These are most often chemicals that also act as surfactants (surface active agents) to foam in the presence of water. These foamers permit air or gas drilling through water-bearing formations.

Lost Circulation Materials: The primary function of a lost circulation additive is to plug the zone of loss back in the formation away from the face of the borehole so that subsequent operations will not disturb the plug.

Lubricants: Extreme pressure lubricants are designed to reduce torque and increase horsepower at the bit by reducing the coefficient of friction. Certain oils, graphite powder and soaps are used for this purpose. Lubricants often are used in freeing stuck pipe.

Shale Control Inhibitors: Gypsum, sodium silicate and calcium lignosulfonates, as well as lime and salt, are used to control caving by swelling or hydrous disintegration of shales.

Surface Active Agents: Surfactants, as they are called, reduce the interfacial tension between contacting surfaces (water/oil, water/solid, water/air, etc.) These may sometimes be emulsifiers, de-emulsifiers, flocculants or deflocculants, depending on the surfaces involved.

Thinners, Dispersants: These chemicals modify the relationship between the viscosity and percentage of solids in a drilling mud and may be used further to vary the gel strength, increase a fluid's "pumpability," etc. Tannins (quebracho), various polyphosphates, lignite and lignosulfonates materials are chosen as thinners, or as dispersants, since most of these chemicals also remove solids by precipitation or sequestering, and deflocculation reactions. Principal purpose of a thinner is to function as a deflocculant to combat random association of clay particles.

Viscosifiers: Bentonite, CMC, attapulgite clays and subbentonites (all colloids) are used as viscosity builders for fluids to assure a high viscosity-solids relationship.

Weighting Materials: Barite, lead compounds, iron oxides and similar products possessing high specific gravity are used to control formation pressures, check formation caving, facilitate pulling dry pipe, as an aid in combating some types of circulation loss and in well completion operations.

ADDITIVE APPLICATION & COST

Table A-12

Additive	Recommended Use								Estimated Cost (\$)	Mix Ratio (Per 100 BBLS, except as noted)
	Low pH			High pH						
	Fresh Water	Brackish Water	Sat. Saltwater	Gyp-treated Fluid	Lime-treated Fluid	Fresh Water Fluid	Invert Emulsion Mud	Oil Mud		
ALKALINITY										
Caustic Soda	.	.	.	.	.	.			.59/lb.	10-300 lbs.
Soda Ash	.	.	.	.	.	.			.21/lb.	50-200 lbs.
Calcium Chloride		.	.	.	.	.	.	.	.46/lb.	2000-20000 lbs.
Lime					.		.	.	.11/lb.	50-800 lbs.
BACTERICIDES										
Caustic Soda	.	.	.	.	.	.			.59/lb.	10-300 lbs.
Lime					.		.	.	.11/lb.	50-800 lbs.
CALCIUM REMOVER										
Soda Ash	.	.	.	.	.	.			.21/lb.	50-200 lbs.
Caustic Soda	.	.	.	.	.	.			.59/lb.	10-300 lbs.
CORROSION INHIBITORS										
Film Forming Amine	.	.	.	.	.	.		.	12.00/gal.	5-10 gal.
Zinc Carbonate	.	.	.	.	.	.	.	.	2.16/lb.	100-300 lbs.
DEFOAMER										
Surface-active	.	.	.	.	.	.	.		16.41/lb.	1-10 lbs.
EMULSIFIER										
---	.	.	.	.	.	.	.		4.32/lb.	10-300 lbs.
---								.	1.80/lb.	500-2500 lbs.
FILTRATE REDUCER										
High Weight Polymer								.	.42/lb.	500-1500 lbs.
Paraformaldehyde	.	.	.	.	.	.	.		1.40/lb.	20-100 lbs.
FLOCCULANTS										
---	.	.	.	.	.	.	.		1.22/lb.	20-500 lbs.
---	.	.	.	.	.	.	.		2.79/lb.	25-300 lbs.
FOAMING AGENT										
---								.	9.00/gal	1-2 gal. (per 10 gal/Hr.)
LOST CIRC. MATERIAL										
Flakes & Fibers	.	.	.	.	.	.			.63/lb.	10-30 lbs./BBL
Modified hydrocarbon	.	.	.	.	.	.	.	.	.61/lb.	3-6 lbs/BBL
Mica	.	.	.	.	.	.	.	.	.28/lb.	2-15 lbs./BBL
LUBRICANTS										
Modified high-organic-acids	.	.	.	.	.	.			2.71/lb.	400 lbs.
Biodegradable Lubricant	.	.	.	.	.	.			11.46/gal.	12-25 gal.
SHALE CONTROL										
Asphalt	.	.	.	.	.	.	.	.	1.83/lb.	400-600 lbs.
Sulfonated Asphaltines	.	.	.	.	.	.	.	.	1.93/lb.	200-600 lbs.
SURFACE ACT. AGENTS										
Oil Wetting Agent								.	33.15/gal.	10-25 gal.
---	.	.	.	.	.	.			10.35/gal.	2-4 gal.
THINNERS										
Chrome lignosulfonate	.	.	.	.	.	.			.67/lb.	100-1000 lbs.
Organic Thinner	.	.	.	.	.	.			2.15/lb.	50-300 lbs.
VISCOFIERS										
Bentonite	.	.	.	.	.	.			.06/lb.	500-2500 lbs.
Attapulgite Clay		.	.	.	.	.			.13/lb.	500-3000 lbs.
WEIGHTING MATERIALS										
Barium Sulfate	.	.	.	.	.	.	.	.	.06/lb.	As Required
Graded Calcium Carbonate	.	.	.	.	.	.	.	.	.11/lb.	As Required

Build cost for invert emulsion and
lignosulfonate muds

Empirical maintenance costs for invert
emulsion and lignosulfonate muds

Example Drilling Fluid Costs

Figure A-3

Reference: Adams, Neal J. and Tommie Charrick, Drilling Engineering, PennWell Publishing Co., 1985, pp. 756-757.

1.8 CEMENT PROGRAM

Definition

In oilfield operations, cement is primarily used to fill the annular space between the casing string and the hole wall. Its functions are to provide casing support, prevent fluid movement between formations and the surface, protect fresh water zones, and assist in resolving various hole problems. The cement program defines the types and volumes of cements, and where they are to be used.

Selection

The main classifications of cements and their individual characteristics are noted in Table A-14. Numerous additives are available that can modify or enhance these characteristics so that the cements can be used for specific well conditions. These additives, their functions, examples and representative costs are noted in Tables A-15 and A-16. Additional information concerning the technical aspects of different additives, and how to properly combine them with cements can be obtained from cement companies such as Halliburton.

The cost of the cement program is based upon the type and volume of cement and additives used. Typical cement costs are noted in Table A-13. To determine which cement type and needed additives to use, consider the specific characteristics of the well, such as temperature, pressure, depth, etc., and then select that combination of materials that best suits these conditions.

The total volume required is dependent upon the hole diameter and the fill height. Normally, the surface casing is cemented from the casing point to the surface. Intermediate and production strings generally have 200 to 300 feet of fill in the annulus.

In the actual computation of cement volume, the model program uses a factor of 150% of the theoretical volume to determine the needed volume. This excess is required to compensate for spillage, hole diameter variation, cement left in casing, etc.

Data Entry Requirements

Considering the environment of the well bore, select the cement type for each zone from Table A-14 and, if desired, enter it in the appropriate cell for each zone on line 92. This information is for reference purposes only. The volume of cement is automatically calculated by the program. However, fill height must be stated. Determine the fill height (Ft.) required in each zone and enter this data in the appropriate zone cells on line 93. Unit cost is the total cost of the cement and additives required per cubic foot. Using Tables A-13 and A-16, determine the unit cost (\$/Ft.³) for each zone and enter it in the appropriate cell for each zone on line 94.

CEMENT COSTS (Estimated)

Table A-13

Cement Class (API)	Cost (\$/Ft. ³)
Class A	6.00-7.50
Class H	5.50-7.00

OIL WELL CEMENT
CLASSIFICATIONS⁽¹⁾

Table A-14

API Classification	Approximate Well Depth (Fr.)	Approximate Stat. Temp. Range (°F)	24-Hr. Compressive Strength, 110°F (psi)	Characteristics
A	0-6,000	80-170	4000	Use when special prop- erties are not required. Economical compared to premium cement.
B	0-6,000	80-170		Use when moderate sulfate resistance is required. Economical in cost.
C	0-6,000	80-170	2700	Use when high early strength is required. Available in regular and high sulfate-resistant types.
D	6,000-10,000	170-230		Use when moderately high temperatures and press- ures are encountered. Available in regular and high sulfate-resistant types.
E	6,000-14,000	170-290		Use when high temper- atures and pressures are encountered. Available in regular and high sulfate-resistant types.
F	10,000-16,000	230-320		Use when extremely high temperatures and press- ures are encountered. Available in regular and high sulfate-resistant types.
G	0-8,000	80-200	3000	A basic cement compat- able for use with accel- erators or retarders. Available in moderate and high sulfate- resistant types.
H	0-8,000	80-200	3700	A basic cement compat- able for use with accel- erators or retarders. Available in moderate and high sulfate- resistant types. Slurry weight is slightly less than Class G.
I	12,000-16,000	170-320		Use when extremely high temperatures and press- ures are encountered. Compatible with acceler- ators and retarders.

Reference: (1) API

ADDITIVE FUNCTION

Table A-15

Accelerators: Added to cement or mixing water to shorten the waiting time to reach acceptable strength limits. Calcium chloride is commonly used.

Retarders: Extends the pumpability of the cement for deep well operations. Well temperatures must be considered when using these additives. Calcium lignosulfonate is commonly used below 200 F. Organic acids, borax, etc., are used above this temperature. Silica flour is also used to compensate for strength retrogression.

Light Weight Additives: Reduces slurry density. Used for formations with low fracture gradients, etc. Pozzolans, perlite, bentonite, etc. are commonly used materials.

Heavy Weight Additives: Increases slurry density. Used when high pressures are encountered, etc. Commonly used materials are sand, barite and hematite.

Lost Circulation Materials: Added to cements that are used to control lost circulation problems. Fibrous, granular and lamella-type materials are often used.

Fluid Loss Control: Reduces filtration or water loss rates. Also improves bonding and minimizes formation damage. Cellulose derivatives are commonly used.

Special Additives: Special additives used to reduce friction, improve bonding in salt zones, combat the effect of highly treated muds on the cement etc.

ADDITIVE COSTS AND MIX RATIOS
(Estimated)

Table A-16

A-37

Function	Cement			
	Class A		Class H	
	Cost	Mix Rate	Cost	Mix Ratio
Accelerators	\$.25 - .40/lb.	2 - 8 lbs./Sack Cem.	\$.25 - .40/lb.	2 - 8 lbs./Sack Cem.
Retarders	\$2.00 - 3.00/lb.	.3 - .5 lbs./Sack Cem.	\$2.00 - 3.00/lb.	.3 - 1.0 lbs./Sack Cem.
Light Wt. Additives				
Natural Hydrocarbon	\$.35 - .45/lb.	20 - 30 lbs./Sack Cem.	\$.35 - .45/lb.	20 - 30 lbs./Sack Cem.
Diatomaceous Earth	\$.35 - .45/lb.	1.5 - 5.0 lbs./Sack Cem.	\$.35 - .40/lb.	1.5 - 5.0 lbs./Sack Cem.
Heavy Wt. Additives				
Sand	\$.06 - .08/lb.	30 - 80 lbs./Sack Cem.	\$.06 - .08/lb.	30 - 80 lbs./Sack Cem.
Barite	\$.05 - .07/lb.	20 - 60 lbs./Sack Cem.	\$.05 - .07/lb.	20 - 60 lbs./Sack Cem.
Lost Circ. Material				
Natural Hydrocarbon	\$.35 - .45/lb.	1 - 100 lbs./Sack Cem.	\$.35 - .45/lb.	1 - 100 lbs./Sack Cem.
Walnut Shells	\$.30 - .40/lb.	2 - 8 lbs./Sack Cem.	\$.30 - .40/lb.	2 - 8 lbs./Sack Cem.
Cellulose Flakes	\$1.20 - 1.30/lb.	.5 - 2.0 lbs./Sack Cem.	\$1.20 - 1.30/lb.	.5 - 2.0 lbs./Sack Cem.
Fluid Loss Control	\$4.50 - 6.00/lb.	2 - 4 lbs./Sack Cem.	\$4.50 - 6.00/lb.	2 - 4 lbs./Sack Cem.
Special Additives				
Friction Reducers	\$2.70 - 3.70/lb.	.2 - 1.0 lbs./Sack Cem.	\$2.70 - 3.70/lb.	.2 - 1.0 lbs./Sack Cem.
High Temp.	\$.12 - .14/lb.	25 - 35 lbs./Sack Cem.	\$.12 - .14/lb.	25 - 35 lbs./Sack Cem.

Note: 1) 1 Sack of Cement = 1 Ft.³

2) For Modeling purposes, disregard the volume increase caused by the addition of an additive to the cement.

1.9 AUXILIARY OPERATIONS

Definition

When drilling, special auxiliary services are required that the rig crew may not possess. If the crew does not have the capabilities required, they must rent them from local service groups. These operations include well surveying, electric and/or radioactive logging, mud logging, etc.

Selection

Auxiliary operations include:

Surveying
Logging
Other

Surveys are run to assure that the hole is being drilled within the limits of straight hole deviation or to determine the actual deviation angle being drilled. These surveys are often run after each bit run in deep holes, or at shorter intervals in deviated holes. Rig crews normally possess surveying equipment and are capable of running surveys.

Electric and radioactive logs are usually run when a well has reached bottom, or periodically at the deeper depths of deep well drilling operations. This is particularly true for exploratory wells.

Mud Logging is usually used for deep well drilling, exploratory drilling, or when drilling in dangerous areas such as geopressured zones. Mud logging, and electric and radioactive logging are usually rented services.

Data Entry Requirements

Considering the type of well being drilled, determine the number of surveying runs, logging runs and other auxiliary operations required for each zone. Enter these numbers in the appropriate cells for each zone on lines 99, 100, and 101.

1.10 BOTTOMHOLE ASSEMBLY (BHA) CHANGES

Definition

The bottomhole assembly (BHA) is essentially the portion of the drillstring below the drill pipe. It normally includes the drill collar and drilling tools, such as deviation subs, telemetry equipment, shock subs, reamers, etc. Its complexity can vary. BHA changes refers to the number of times the assembly is changed in each zone. If changes are required they are normally done whenever the pipe is tripped out of the hole for bit changes, etc.. However, if one is building up angle for a deviated well operation, BHA changes will be required more frequently. Thus, the number of times a BHA change is required is dependent upon the specific drilling operation involved.

Data Entry Requirements

Considering the type of hole being drilled (straight hole, deviated, etc.) and the type of bottomhole assemblies used, determine the number of times the BHA will be changed in each zone. Enter these numbers in the appropriate cell for each zone on line 103.

FUNCTIONAL SPECIFICATIONS
DATABASE A

FUNCTIONAL SPECIFICATIONS
DATABASE A

Line No.	Field Heading	Input Requirements	Error/Warning Message
		<u>SECTION 1.1</u>	
8	Geologic Evaluation	1) Protected Field - No entry	
9	Classification No.	1) If Hole Depth from surface (line 12) is > 0, then Classification Number must be > 0. 2) Default values are 1 - 7.	1) E40-Input value required 2) W25-Entry invalid for default
		<u>SECTION 1.2</u>	
11	Well Geometry	1) Protected Field - No entry	
12	Hole Depth From Surface (Ft.)	1) If Zone = A, Depth must be > 0. 2) If Hole Diam. (In.) (line 13) is > 0, then Hole Depth must be > 0. 3) Hole Depth must be < Hole Depth for next zone (except when next zone Hole Depth = 0 or Zone = G) 4) Hole Depth must be > Hole Depth of previous zone (except when Zone = A) 5) Suggested limits are 0 - 50,000	1) E40-Input value required 2) E40-Input value required 3) E23-Value exceeds next Zone 4) E20-Value less than prev. Zone 5) W10-Exceeds recommended limits
13	Hole Diameter (In.)	1) If Zone = A, diameter must be > 0. 2) If Hole Depth (line 12) is > 0, then Hole Diam. must be > 0. 3) Hole Diam. must be > Diam. for next zone (except when next Diam. = 0 or Zone = G) 4) Hole Diam. must be < Diam. for previous zone (except when Zone = A) 5) Suggested limits are 0 - 100	1) E40-Input value required 2) E40-Input value required 3) E21-Value less than next Zone 4) E22-Value exceeds prev. Zone 5) W10-Exceeds recommended limits

FUNCTIONAL SPECIFICATIONS
DATABASE A

Line No.	Field Heading	Input Requirements	Error/Warning Message
<u>SECTION 1.3</u>			
15	Casing Program	1) Protected Field - No entry	
16	Casing/Liner Length (Ft.)	1) If Casing/Liner Diam. (line 17) or Unit Cost (line 18) is > 0, then Casing/Liner length must be > 0. 2) Casing/Liner Length must be < Hole Depth (line 12) 3) Suggested limits are 0 - 50,000	1) E40-Input value required 2) E31-Exceeds zone depth 3) W10-Exceeds recommended limits
17	Casing/Liner Diam. (In.)	1) If Casing/Liner Length (line 16) or Unit Cost (line 18) is > 0, then Casing/Liner Diam. must be > 0. 2) Casing/liner Diam. must be < Hole Diam. (line 13) 3) Casing Diam. must be > Casing Diam. in next zone (except when Casing Diam. next zone = 0 or Zone = G). 4) Casing Diam. must be < Casing Diam. in previous zone (except when Zone = A) 5) Suggested limits are 0 - 60.	1) E40-Input value required 2) E30-Casing exceeds hole diam. 3) E21-Value less than next Zone 4) E22-Value exceeds prev. Zone 5) W10-Exceeds recommended limits
18	Unit Cost (\$/100')	1) If Casing/Liner Length (line 16) or Casing/Liner Diam. (line 17) is > 0, then Unit Cost must be > 0. 2) Suggested limits are 0 - 10,000	1) E40-Input value require 2) W10-Exceeds recommended limits
<u>SECTION 1.4</u>			
20	Drilling Techniques & Equipment Used	1) Protected Field - No entry	
21	Drilling Method (% Time) (1)	1) Protected Field - No entry	

FUNCTIONAL SPECIFICATIONS
DATABASE A

Line No.	Field Heading	Input Requirements	Error/Warning Message
	Lines 22 - 45	<ol style="list-style-type: none"> 1) Lines 22, 27, 30, 35, 40, and 45 must sum up to equal 100. (Drilling Method (% Time) (line 21) will be displayed in the error message display area if this error occurs.) 2) Lines 22 - 46 must be ≥ 0 or ≤ 0. 	<ol style="list-style-type: none"> 1) E11-Invalid percentages 2) E12-Invalid percent
46	Reaming	<ol style="list-style-type: none"> 1) If Total Hole Depth (line 12) is in error, Reaming will not be verified. 2) If present, must be $\leq$ Total Hole Depth. Change (current depth - prev. zone depth). 	<ol style="list-style-type: none"> 1) E34-Invalid hole depth 2) E33-Exceeds zone depth change
		<u>SECTION 1.5</u>	
48	Rig Selection	<ol style="list-style-type: none"> 1) Must be 1-6 for default PGM to work (this field is checked only when Zone = A) 	<ol style="list-style-type: none"> 1) W25-Entry invalid for default
		<u>SECTION 1.6</u>	
50	Bit Program	<ol style="list-style-type: none"> 1) Protected Field - No entry 	
51	Rotary Drilling-Air	<ol style="list-style-type: none"> 1) Protected Field - No entry 	
52	Bit Selection	<ol style="list-style-type: none"> 1) Descriptive Field - No edits performed 	
53	Bit Cost (\$/Bit)	<ol style="list-style-type: none"> 1) If Rotary Drilling - Air (line 22) is > 0, then Bit Cost must be > 0. 2) Suggested limits are 0 - 10,000 3) If Bit Cost > 0 and Rotary Drilling - Air = 0, warning message will occur. (You may assign a cost to an unused drlg. method, but may not select a method without assigning a cost.) 	<ol style="list-style-type: none"> 1) E40-Input value required 2) W10-Exceeds recommended limits 3) W15-Drlg. method not indicated

FUNCTIONAL SPECIFICATIONS
DATABASE A

Line No.	Field Heading	Input Requirements	Error/Warning Message
54	Bit Life (Avg. Hrs.)	1) If Rotary Drilling - Air (line 22) is > 0, then Bit Life must be > 0. 2) Suggested limits are 0 - 500	1) E40-Input value required 2) W10-Exceeds recommended limits
55	Rotary Drilling-Mud	1) Protected Field - No entry	
56	Bit Selection	1) Descriptive Field - No edits performed	
57	Bit Cost (\$/Bit)	1) If Rotary Drilling - Mud (line 27) is > 0, then Bit Cost must be > 0. 2) Suggested limits are 0 - 10,000 3) Same as edit #3, line 53 (Bit Cost)	1) E40-Input value required 2) W10-Exceeds recommended limits W15-Drlg. Method not indicated
58	Bit Life (Avg. Hrs.)	1) If Rotary Drilling - Mud (line 27) is > 0, then Bit Life must be > 0. 2) Suggested limits are 0 - 10,000	1) E40-Input value required 2) W10-Exceed recommended limits
59	Downhole Motor-Mud	1) Protected Field - No entry	
60	Bit Selection	1) Descriptive Field - No edits performed	
61	Bit Cost (\$/Bit)	1) If Downhole Motor - Mud (line 30) is > 0, then Bit Cost must be > 0. 2) Suggested limits are 0 - 10,000 3) Same as edit #3, line 53 (Bit Cost)	1) E40-Input value required 2) W10-Exceeds recommended limits 3) W15-Drlg. Method not indicated
62	Bit Life (Avg. Hrs.)	1) If Downhole Motor - Mud (line 30) is > 0, then Bit Life must be > 0. 2) Suggested limits are 0 - 500	1) E40-Input value required 2) W10-Exceeds recommended limits
63	Core Drilling-Conv.	1) Protected Field - No entry	
64	Bit Selection	1) Descriptive Field - No edits performed	

FUNCTIONAL SPECIFICATIONS
DATABASE A

Line No.	Field Heading	Input Requirements	Error/Warning Message
	Bit Cost (\$/Bit)	1) If Core Drilling - Conv. (line 35) is > 0, then Bit Cost must be > 0. 2) Suggested limits are 0 - 10,000 3) Same as edit #3, line 53 (Bit Cost)	1) E40-Input value required 2) W10-Exceeds recommended limits 3) W15-Drlg. Method not indicated
66	Bit Life (Avg. Hrs.)	1) If Core Drilling - Conv. (line 35) is > 0, then Bit Life must be > 0. 2) Suggested limits are 0 - 500.	1) E40-Input value required 2) W10-Exceeds recommended limits
67	Core Drilling- Wireline	1) Protected Field - No entry	
68	Bit Selection	1) Descriptive Field - No edits performed	
69	Bit Cost (\$/Bit)	1) If Core Drilling - Wireline (line 40) is > 0, then Bit Cost must be > 0. 2) Suggested limits are 0 - 10,000. 3) Same as edit #3, line 53 (Bit Cost)	1) E40-Input value required 2) W10-Exceeds recommended limits 3) W15-Drlg. Method not indicated
70	Bit Life (Avg. Hrs.)	1) If Core Drilling - Wireline (line 40) is > 0, then Bit Life must be > 0.	1) E40-Input value required
71	Other	1) Protected Field - No entry	
72	Cutter Selection	1) Descriptive Field - No edits performed	
73	Cost (\$)	1) If Other (line 45) is > 0, then Cost must be > 0. 2) Suggested limits are 0 - 100,000 3) Same as edit #3, line 53 (Bit Cost)	1) E40-Input value required 2) W10-Exceeds recommended limits 3) W15-Drlg. Method not indicated
74	Cutter Life (Avg. Hrs.)	1) If Other (line 45) is > 0, then Cutter Life must be > 0. 2) Suggested limits are 0 - 500.	1) E40-Input value required 2) W10-Exceeds recommended limits

FUNCTIONAL SPECIFICATIONS
DATABASE A

Line No.	Field Heading	Input Requirements	Error/Warning Messages
		<u>SECTION 1.7</u>	
76	Drilling Fluids Prg.	1) Protected Field - No entry	
77	Surface System Build Up	1) Protected Field - No entry	
78	Surface System Volume (bbls.)	1) Surface System Vol. must be > 0, if Rotary Drilling - Air (line 22) (all zones) is < 100%. (Validated in Zone A only) 2) If Total Unit Cost (line 80) is > 0, Surface System Vol. must be > 0. 3) Suggested limits are 0 - 5000.	1) E32-Fluids program required 2) E40-Input value required 3) W10-Exceeds recommended limits
79	Additives (Types)	1) Descriptive Field - No edits performed	
80	Total Unit Cost (\$/100 bbls.)	1) Must be > 0 if Surface System Vol. (line 78) is > 0. 2) Must be 0 if Surface System Vol. (line 78) = 0 3) Suggested limits are 0 - 50,000	1) E40-Input value required 2) E39-Invalid entry 3) W10-Exceeds recommended limits
81	Additional Volume	1) Protected Field - No entry	
82	Additives (Types)	1) Descriptive Field - No edits performed	
83	Total Additional Cost (\$/100 bbls.)	1) Must be > 0 if Cost (line 85) is > 0. 2) Suggested limits are 0 - 20,000	1) E40-Input value required 2) W10-Exceeds recommended limits
84	Daily Maintenance	1) Protected Field - No entry	
85	Cost (\$/Day)	1) Must be > 0 if Total Additional Cost (line 83) is > 0. 2) Suggested limits are 0 - 5,000	1) E40-Input value required 2) W10-Exceeds recommended limits

FUNCTIONAL SPECIFICATIONS
DATABASE A

Line No.	Field Heading	Input Requirements	Error/Warning Message
86	Other	1) Protected Field - No entry	
87	Equipment Cost (\$)	1) Suggested limits are 0 - 200,000	1) W10-Exceeds recommended limits
88	Additives	1) Descriptive Field - No edits performed	
89	Unit Cost (\$/Cu. Ft. of Hole)	1) Suggested limits are 0 - 50,000	2) W10-Exceeds recommended limits
<u>SECTION 1.8</u>			
91	Cement Program	1) Protected Field - No entry	
92	Cement Type	1) Descriptive Field - No edits performed	
93	Annulus Fill Ht. (Ft.)	1) If present, must be < = Hole Depth from Surface (line 12) 2) Must be > 0 if Unit Cost (line 94) is > 0.	1) E34-Invalid hole depth 2) E40-Input value required
94	Unit Cost (\$/Cu. Ft.)	1) Must be > 0 if Annulus Fill Ht. (line 93) is > 0. 2) Suggested limits are 0 - 100	1) E40-Input value required 2) W10-Exceeds recommended limits
<u>SECTION 1.9</u>			
98	Auxiliary Operations	1) Protected Field - No entry	
99	Survey (No. of Runs)	1) Suggested limits are 0 - 50	1) W10-Exceeds recommended limits
100	Logging (No. of Runs)	1) Suggested limits are 0 - 50	1) W10-Exceeds recommended limits
101	Other (No. of Runs)	1) Suggested limits are 0 - 50	1) W10-Exceeds recommended limits
<u>SECTION 1.10</u>			
103	Bottomhole Assembly (BHA) Changes	1) Suggested limits are 0 - 50	1) W10-Exceeds recommended limits

III.

DATABASE B

OPERATION TIME AND COST DATA

DATABASE B

TABLE OF CONTENTS

	Page
2.1 Road Location and Site Preparation	B-2
2.2 Initiation	B-4
2.3 Rig Movement	B-5
2.4 Rig Operating Rates.	B-7
2.5 Fuel Consumption	B-11
2.6 Fuel Cost.	B-13
2.7 Transportation and Misc. Costs	B-14
2.8 Rental Costs	B-15
2.9 Special Tool Cost.	B-16
2.10 Supervision Cost	B-20
2.11 Condition Drilling Fluids.	B-21
2.12 Water Cost	B-22
2.13 Bit Change	B-24
2.14 Bottomhole Assembly (BHA) Change	B-25
2.15 Drilling Penetration Rates	B-26
2.16 Reaming Operations	B-28
2.17 Pipe Handling Operations	B-30
2.18 Auxiliary Operations - Surveying	B-32
2.19 Auxiliary Operations - Logging	B-34
2.20 Auxiliary Operations - Other	B-36
2.21 Coring Operations.	B-37
2.22 Casing Operations.	B-40
2.23 Cementing Operations	B-42
2.24 Wellhead Equipment and Installation.	B-44
2.25 Maintenance and Drilling Problems.	B-47

2.1 ROAD LOCATION AND SITE PREPARATION

Definition

This activity consists of locating and/or preparing access roads to the drill site, development of the drill site and the drilling pad, digging and lining reserve mud pits when required, and other activities necessary prior to the start of any drilling operations.

Time

Time is not considered, because this operation is a direct cost item.

Cost

Costs vary sharply from location to location, because of terrain conditions, such as swamps, mountains, jungle, plains, etc., soil conditions, remoteness, environmental problems and rig size. Table B-1 lists a series of representative cost estimates.

Data Entry Requirements

Using Table B-1 select the terrain conditions most suitable for the drilling model. Having selected the terrain and considering the rig classification entered in Section 1.5, line 48 determine the location and site preparation cost (\$) from Table B-1. Enter this data in the appropriate cell on line 8.

ROAD LOCATION AND SITE PREPARATION
OPERATION COST
(Estimated)

Table B-1

Rig Classification		Terrain/Environment		
Class	Estimated Drlg. Depth Rating (Ft.)	Plains Area, Normal Environment (\$)	Mountains, Sensitive Environment (\$)	Jungle, Swamp, Sensitive Environment (\$)
1	8,000	24,800	43,150	65,450
2	12,000	34,750	63,550	95,250
3	16,000	47,200	88,600	132,500
4	20,000	55,200	113,850	169,750
5	30,000	68,800	144,150	214,450
6	50,000	89,550	174,450	259,150

Note: The construction of a 1 mile gravel/rock road is included in the above cost estimates.
Additional construction cost per mile of road, may be added as follows:

Plains Area - \$9,800
Mountains - \$12,900
Jungle/Swamp - \$20,700

2.2 INITIATION

Definition

Initiation consists of drilling and casing a large diameter, shallow hole (cellar) over the well site to stabilize the surface ground material. During this operation a large diameter conduit is placed in the hole and cemented in position. In addition, the mouse hole and the rat hole are drilled. These operations are performed by a small rig, prior to the rig up of the main drilling rig.

Time

Time is not considered, because this operation is a direct cost item.

Cost

Operation cost will vary based on the dimensions of the conduit required and the depth and diameter of the drilled hole. This cost includes drilling costs, conduit costs, and cementing costs. Representative total costs are noted in Table B-2.

INITIATION
(Estimated)

Table B-2

Pipe Diam. (In.)	Hole Depth (Ft.)	Oper. Cost (\$)
30	50	13,000
30	90	22,000
42	90	28,000

Data Entry Requirements

Using Table B-2, select the pipe diameter and hole depth desired, and then enter the operation cost (\$) and hole depth (Ft.) in the appropriate cells on line 10. Hole depth will be entered in the Misc. column cell.

2.3 RIG MOVEMENT

Definition

Rig movement consists of rigging-down and moving the rig to the new drilling site (demobilization) and rigging-up the rig (mobilization) at the new drill site.

Time

Time will vary based on the size of the rig involved and the distance (estimated to be 20 miles) from the old drill site to the new one. Average times are noted in Table B-3.

Cost

Cost will vary based on the size of the rig involved and the distance (estimated to be 20 miles) from the old drill site to the new one. Average costs are noted in Table B-3.

Data Entry Requirements

The computer will automatically select the demobilization and mobilization, time (Hrs.) and cost (\$) factors from Table B-3, based on the rig classification entered in Section 1.5, line 48. If the time and cost data displayed on lines 13 and 14 is unacceptable, it can be changed as desired.

RIG MOVEMENT
(Estimated)

Table B-3

Rig Classification		Demobilization (1)		Mobilization (2)	
Class	Est. Drlg. Depth Rating (Ft.)	Operation Time (Avg. Hrs.)	Operation Cost (\$)	Operation Time (Avg. Hrs.)	Operation Cost (\$)
1	8,000	72	12,360	48	9,860
2	12,000	120	20,600	72	15,600
3	16,000	144	25,125	72	17,625
4	20,000	168	29,650	96	22,150
5	30,000	216	38,700	96	26,200
6	50,000	288	54,300	120	36,800

Note: (1) Demobilization includes time and cost of rig down and moving (estimated to be 20 miles).

(2) Mobilization includes time and cost of rig up.

2.4 RIG OPERATING RATES

Definition

Rig operating rates are the standard cost rates charged by the rig owner for use of the rig. These rates include labor costs, rig replacement costs, insurance, finance charges, taxes, general and administrative costs, profits, etc.

Costs

There are two common methods of charging for the use of a drilling rig. They are:

- Day Rate (Daywork)
- Footage Rate

Daywork is the most common. In this type of contract the rig operator specifies several different operating conditions and charges the client accordingly. The basic categories are: Standby and Force Majeure, Rig with Pipe, and Rig without Pipe. When this type of contract is used, the above rates are normally charged (on a daily basis) regardless of how long it takes to drill the well.

Footage rate is a rig useage rate based on a single charge per foot drilled. The amount of time required to drill the well, maintenance charges, force majeure, etc. are not normally considered. Although this is the most profitable type of contract for each party, both the contractor and the operator must be keenly aware of what they are doing.

Both of the above methods vary by location and rig size. Tables B-4 and B-5 list a series of different operating rates for oil and gas drilling, and geothermal drilling.

To use this data, the operator must consider the area in which he will be drilling, the size of the rig he will be using and the type of well to be drilled. The user should then determine the method of billing desired. Based on these factors he can determine a rig operating rate.

Data Entry Requirements

Considering the rig classification noted in Section 1.5, line 48, the type of day rate or footage rate desired, the geological area, and the type of well (oil, gas, geothermal) to be drilled, select from either Table B-4 or B-5 the appropriate operating rates (\$) and enter the data in the appropriate cells on line 18 through 22. If Day Rate is desired, data from both Standby/Nondrilling and either Rig With Pipe, Rig Without Pipe or Other must be entered. If Footage Rate is desired, only the footage rate must be entered.

RIG OPERATING RATES
(Oil and Gas Drilling)

Table B-4

Rig Classification		Day Rate ^{(1) (2)}				Footage Rate (\$/Ft.)		
Class	Est. Drlg. Depth Rating (Ft.)	Standby/Nondrlg.		Rig With Pipe			Rig W/O Pipe	
		(\$/Day) (\$/Hr.)		(\$/Day) (\$/Hr.)			(\$/Day) (\$/Hr.)	
Texas, Louisiana, Gulf Coast Areas								
1	8,000	4,200	175	4,700	196		12.00	
2	12,000	4,400	183	4,900	204		15.00	
3	16,000	4,600	192	5,100	213			
4	20,000	5,000	208	5,500	229			
5	30,000	6,000	250	7,000	292			
6	50,000							
California Area								
1	8,000	4,200	175	4,700	196			
2	12,000	4,400	183	4,900	204			
3	16,000	4,700	196	5,200	217			
4	20,000							
5	30,000							
6	50,000							
Texas, Oklahoma Areas								
1	8,000	3,700	154	4,200	175		12.50	
2	12,000	4,050	169	4,550	190		18.50	
3	16,000	4,400	183	4,900	204		28.00	
4	20,000	4,800	200	5,300	221			
5	30,000	6,000	250	7,000	292			
6	50,000							

Note: (1) All Day Rates and Footage Rates are based on 1984 average rates for the specific areas, except where estimated. Rates are not shown for some depth categories because no drilling is done to those depths in those areas.

(2) All Rates are estimated, and will vary based upon utilization demand.

RIG OPERATING RATES
(Geothermal Drilling)

Table B-5

Rig Classification		Day Rate (1) (2)			
Class	Est. Drlg. Depth Rating (Ft.)	Standby/Nondrlg.		Rig With Pipe (3)	
		(\$/Day)	(\$/Hr.)	(\$/Day)	(\$/Hr.)
1	8,000	3,360	140	5,760	240
2	12,000	3,840	160	6,240	260

- Notes: (1) All Day Rates are based on 1986 Average rates for both upper and lower California areas.
- (2) All Rates are estimated and will vary based upon utilization demand.
- (3) A charge of \$15,000 to \$20,000 is included in this rate to compensate for pipe repair.

2.5 FUEL CONSUMPTION

Definition

Fuel consumption is the volume of fuel required to operate the primary power source of a drilling rig, for a specific period of time. The volume required will vary based upon the depth rating of the rig (total continuous H.P.) and the operation it is performing.

Fuel consumption is estimated for three different operations, for each of the rigs defined in Section 1.5. Nondrilling operations include running casing, cementing, testing rig maintenance operations, and surveying. Drilling operations refers to the actual time on bottom rotating. Tripping operations includes all time devoted to tripping pipe in or out of the hole. In each operation, for each rig, a different power requirement is necessary. It must be noted that the stated fuel consumption can vary considerably based upon the prevailing conditions during the actual operation.

Time

Fuel consumption is based on an hourly rate.

Data Entry Requirements

The computer will automatically select fuel consumption rates from Table B-6, based on the rig classification entered in Section 1.5, line 48. If the fuel consumption rates displayed on lines 25 through 33 are unacceptable, they can be changed as desired.

FUEL CONSUMPTION
(Estimated)

Table B-6

Rig Classification		Operation	Primary Power Requirements (Estimated)	Continuous Power Output (H.P.)	Estimated Fuel Consumption (Gal./Hr.)
Class	Est. Drlg. Depth Rating (Ft.)				
1	8,000	Standby/Nondrilling	1 Engine @ 1/2 power	116	6.5
		Drilling	1 Engine @ Full power	233	13.1
		Tripping			
		0 - 4,999'	2 Engines @ 3/4 power	350	19.6
2	12,000	5,000 - 8,000'	2 Engines @ Full power	466	26.2
		Standby/Nondrilling	1 Gen. set @ 1/2 power	280	15.7
		Drilling	2 Gen. sets @ Full power	1,120	62.7
		Tripping			
3	16,000	0 - 4,999'	2 Gen. sets @ 1/3 power	370	20.7
		5,000 - 9,999'	2 Gen. sets @ Full power	1,120	62.7
		10,000 - 12,000'	3 Gen. sets @ Full power	1,680	94.1
		Standby/Nondrilling	1 Gen. set @ 1/2 power	375	20.6
4	20,000	Drilling	2 Gen. sets @ Full power	1,500	82.5
		Tripping			
		0 - 4,999'	2 Gen. sets @ 1/3 power	500	27.5
		5,000 - 9,999'	3 Gen. sets @ 1/2 power	1,125	61.9
5	30,000	10,000 - 14,999'	3 Gen. sets @ Full power	2,250	123.8
		15,000 - 16,000'	3 Gen. sets @ Full power	2,250	123.8
		Standby/Nondrilling	1 Gen. set @ 1/2 power	500	27.0
		Drilling	2 Gen. sets @ Full power	2,000	108.0
6	50,000	Tripping			
		0 - 4,999'	1 Gen. set @ 3/4 power	750	40.5
		5,000 - 9,999'	2 Gen. sets @ 1/2 power	1,000	54.0
		10,000 - 14,999'	3 Gen. sets @ 1/2 power	1,500	81.0
7		15,000 - 19,999'	3 Gen. sets @ Full power	3,000	162.0
		20,000 - 30,000'			
		Standby/Nondrilling	1 Gen. set @ 1/2 power	600	30.6
		Drilling	2 Gen. sets @ Full power	2,400	122.4
8		Tripping			
		0 - 4,999'	1 Gen. set @ 3/4 power	900	45.9
		5,000 - 9,999'	2 Gen. sets @ 1/2 power	1,200	61.2
		10,000 - 14,999'	2 Gen. sets @ Full power	2,400	122.4
9		15,000 - 19,999'	3 Gen. sets @ 3/4 power	2,700	137.7
		20,000 - 29,999'	3 Gen. sets @ Full power	3,600	183.6
		30,000 - 50,000'			
		Standby/Nondrilling	1 Gen. set @ 1/2 power	750	38.3
10		Drilling	3 Gen. sets @ Full power	4,500	229.5
		Tripping			
		0 - 4,999'	1 Gen. set @ 3/4 power	1,125	57.4
		5,000 - 9,999'	1 Gen. set @ Full power	1,500	76.6
11		10,000 - 14,999'	2 Gen. sets @ 3/4 power	2,250	114.7
		15,000 - 19,999'	2 Gen. sets @ Full power	3,000	153.2
		20,000 - 29,999'	3 Gen. sets @ Full power	4,500	229.5
		30,000 - 50,000'	4 Gen. sets @ Full power	6,000	306.4

Note: Fuel consumption based on diesel fuel weight of 7.091 Lbs./Gal..

2.6 FUEL COST

Definition

Fuel Cost is the cost of the diesel fuel required to operate the various engines of the drilling rig during operation.

Time

No time factor is allocated to this cost element.

Cost

Fuel costs vary by location, season, etc. A general cost that can be used is:

- Fuel Cost = \$1.00/gal.

Data Entry Requirements

The computer will enter a default value of \$1.00 on line 35. If this value is unacceptable, it can be changed as desired.

2.7 TRANSPORTATION AND MISCELLANEOUS COST

Definition

These costs include the charges for truck transportation for both normal and daily supplies, and for rig maintenance activities. They also include charges for miscellaneous rig services or equipment, such as welding, repair, etc.

Time

Transportation and Miscellaneous costs are based on an hourly rate.

Costs

Average costs for a 25 to 30 day conventional rotary drilling operation are normally in the \$50,000 to \$70,000 range. This equates to an average hourly rate of \$90/hr. A series of these rates are noted in Table B-7.

TRANSPORTATION AND MISCELLANEOUS COSTS
(Estimated)

Table B-7

Rig Classification		Trans. and Misc. Costs	
Class	Estimated Drllg. Depth Rating (Ft.)		
		\$/Day	\$/Hr.
1	8,000	1,950	80
2	12,000	2,000	85
3	16,000	2,150	90
4	20,000	2,400	100
5	30,000	3,000	125
6	50,000	3,600	150

Data Entry Requirements

The computer will automatically select a Transportation and Miscellaneous cost value from Table B-7 based on the rig classification entered in Section 1.5, line 48. If the value displayed on line 37 is unacceptable it can be changed as desired.

2.8 RENTAL COSTS

Definition

Rental costs are those charges for individual rental items that are not significant enough to be separately categorized. Examples of such charges are, rotating heads, surveying collars, small compressors, automatic chokes, BOP equipment, etc.

Time

All charges are normally based on a daily rate. However for purposes of this model, these charges have been converted to an hourly rate (\$/Hr.).

Cost

Rental costs vary based on the size of the rig, the location and the particular drilling operation being performed. A series of representative costs are noted in Table B-8.

RENTAL COSTS
(Estimated)

Table B-8

Rig Classification		Rental Cost	
Class	Estimated Drlg. Depth Rating (Ft.)		
		\$/Day	\$/Hr.
1	8,000	3,600	150
2	12,000	3,750	155
3	16,000	3,850	160
4	20,000	4,100	170
5	30,000	4,450	185
6	50,000	4,800	200

Data Entry Requirements

The computer will automatically select a Rental Cost Value from Table B-8 based on the rig classification entered in Section 1.5, line 48. If the value displayed on line 39 is unacceptable, it can be changed as desired.

2.9 SPECIAL TOOL COST

Definition

These costs include all charges for specialized equipment such as downhole telemetry systems (MWD), downhole motors, deviation subs, etc.

Time

The costs are often based on a composite rate consisting of a minimum amount of time charged and an hourly or daily charge thereafter.

Cost

The costs of these items vary considerably from one item to another, and from location to location. A listing of different rental items and their individual charges follows. In each case the charges are equated to a representative, average hourly rate, so that they can be used in this program.

Data Entry Requirements

Considering the variation of tools used with different drilling techniques, in different zones, as noted in Section 1.4, lines 22 through 45; the variation of tool sizes required for different zones; and the variation of tool rental costs based on tool sizes as noted in Tables B-9, B-10, B-11 and B-12; select from these tables an average Rental Rate (\$) for each of the different tools used in the program and enter this data in the appropriate cells on lines 42 through 52.

Example: If a downhole motor is used in three different zones and its size varies with each zone, determine the average Rental Rate (\$) of the motors used in the three zones and enter this cost data in the appropriate cell on line 44 and/or 49.

AIR EQUIPMENT
(Estimated)
Table B-9

Air Compressors & Auxiliary Equipment:

850 cfm of air at pressures 150 psi to 350 psi
Rental Rate - \$500/day (\$21/Hr.)

Air Hammers:

Hole Size Diam. (In.)	Cost ⁽¹⁾		Rental Rate ⁽²⁾ Total (\$/Hr.)
	Hammers (\$)	Bits (\$)	
4 - 4 3/4	3,500	400 - 550	40
5 1/8 - 5 3/4	5,700	600 - 700	65
6 - 8	6,000	700 - 1400	70
7 3/8 - 8 5/8	9,000	1200 - 1600	105
9 7/8 - 11	12,500	2700 - 3600	155
11 - 15	16,500	4750 - 5700	230

Notes: (1) Varies with size and design
(2) Includes hammer and bit

DOWNHOLE MOTORS
(Estimated)
Table B-10

Tool O.D. (In.)	Bit Size Range ⁽¹⁾ (In.)	Rental Rates ⁽²⁾ Total (\$/Hr.)
Moineau Motor		
5 1/2	6 1/2 - 7 7/8	184
6 1/2	8 3/8 - 9 7/8	192
7 3/4	9 7/8 - 12 1/4	202
9 1/2	12 1/4 - 17 1/2	230
Turbodrill		
5 1/8	6 1/4 - 7 7/8	260
6 3/4	8 3/4 - 9 7/8	309
7 5/8	9 1/2 - 12 1/4	324

Note: (1) Bit size will vary based on type of rock being drilled and motor operating conditions (flow rate, mud wt., etc.).

(2) Rental Rates are based on actual hours of drilling and circulating, with a minimum charge of 8 hrs.

DEVIATION SUBS AND TOOLS
(Estimated)

Table B-11

Tool O.D. (In.)	Rental Rates	
	\$/Day	\$/Hr.
Bent Subs ⁽¹⁾		
4 1/2	20	.83
5 1/2	21	.87
6 5/8	22	.92
Shock Subs ⁽²⁾		
4 3/4	160	6.67
6 1/4	165	6.88
6 3/4	180	7.50
8	200	8.34
Hydraulic Jars ⁽³⁾		
4 3/4	640	26.67
6 1/4	725	30.21
6 3/4	890	37.08
Non Magnetic Drill Collar ⁽⁴⁾		
4 - 4 3/4	39	1.63
5 - 6 1/4	47	1.96
6 1/2 - 6 3/4	51	2.12

Notes: (1) 10 day minimum rental charge
 (2) 5 day minimum rental charge
 (3) 3 day minimum rental charge
 (4) 5 day minimum rental charge

TELEMETRY SYSTEMS
(MWD)

(Estimated)

Table B-12

System	Rental Rates		Services Provided
	(\$/Day)	(\$/Hr.)	
Directional Survey	2750	115	Drift, Azimuth, Magnetic Tool Face, Gravity Tool Face
Directional Logging Service	4750	198	Drift, Azimuth, Magnetic Tool Face, Gravity Tool Face, Gamma Ray
Formation Logging Service	5750	240	Drift, Azimuth, Gamma Ray, Resistivity Temperature

2.10 SUPERVISION COST

Definition

Supervision costs are the cost of providing part-time personnel such as engineers, geologists, etc. at the rig site. These people are usually company (not contractor) personnel.

Time

The costs are based on an hourly rate.

Costs

These costs vary from area to area and are based on the difficulty of drilling and whether drilling is in an exploration or production area. They will also vary somewhat based on the depth of the hole. A series of representative costs are noted in Table B-13.

SUPERVISION COSTS
(Estimated)

Table B-13

Rig Classification		Supervision Cost (\$/Hr.)
Class	Estimated Drlg. Depth Rating (Ft.)	
1	8,000	50
2	12,000	62
3	16,000	62
4	20,000	62
5	30,000	75
6	50,000	75

Data Entry Requirements

The computer will automatically select a Supervision Cost from Table B-13 based on the rig classification entered in Section 1.5, line 48. If the value displayed on line 54 is unacceptable, it can be changed as desired.

2.11 CONDITION DRILLING FLUIDS

Definition

The drilling fluid should always be maintained in a good condition. If it does not have the desired chemical or physical properties, it should be treated accordingly and circulated to assure the even distribution of the additives. This is particularly true prior to casing and cementing operations.

Time

For purposes of this model, a time period of one (1) hour will be used.

- Condition Drilling Fluid Time = 1 Hr.

Cost

The cost of the additives involved is accounted for in the daily maintenance cost, noted in Section 1.7, line 85.

Data Entry Requirements

The computer will enter a default value of 1 Hr. on line 56. If this value is unacceptable, it can be changed as desired.

2.12 WATER COST

Definition

Water is used for numerous purposes during the drilling operation. It is a basic element of the drilling fluid, it is used for washing equipment on the rig floor, etc. Thus water must be obtained prior to the drilling operation and disposed of after the well is completed.

Time

No time factor is allocated to these cost elements.

Cost

Water can be obtained by drilling a shallow well, trucking it in, taking it from a stream or river etc. Disposing of it can be more difficult because of the problems of contamination. In addition, the volume of water required varies with the depth of the well to be drilled. Thus estimating average cost factors is difficult. However a series of estimated costs are noted in Table B-14. These costs are based on trucking water to and from the well site, and disposing of it in controlled areas.

WATER COSTS (Estimated)

Table B-14

Rig Classification		Purchase Cost (\$)	Disposal Cost (\$)
Class	Estimated Drlg. Depth Rating (Ft.)		
1	8,000	780	700
2	12,000	1,050	950
3	16,000	1,300	1,200
4	20,000	2,600	2,400
5	30,000	4,600	4,250
6	50,000	7,800	7,000

Data Entry Requirements

The computer will automatically select water purchase and disposal cost values from Table B-14 based on the rig classification entered in Section 1.5, line 48. If the values displayed on lines 59 and 60 are unacceptable, they can be changed as desired.

2.13 BIT CHANGE

Definition

Bit change refers to the time and cost factors related to the adding of a new bit to the end of the drill string. It includes the cost of the new bit and the time required to change it.

Time

For purposes of this model, a time period of one (1) hour will be used.

- Bit Change Time = 1 Hr.

Cost

The cost of the new bits used is accounted for in Section 1.6, lines 51 through 74.

Data Entry Requirements

The computer will enter a default value of 1 Hr. on line 62. If this value is unacceptable, it can be changed as desired.

2.14 BOTTOMHOLE ASSEMBLY (BHA) CHANGE

Definition

The bottomhole assembly is that portion of the drillstring below the drill pipe. It normally includes the drill collar and the drilling tools, such as deviation subs, telemetry equipment, shock subs, reamers, etc. Its complexity can vary.

Time

Although the time to change these tools varies with the complexity involved, an average time of five (5) hours can be used.

- Bottomhole Assembly Change Time = 5 Hrs.

Cost

The cost factors are applied in those sections of this program that relate to the special tools or components involved.

Data Entry Requirements

The computer will enter a default value of 5 Hrs. on line 64. If this value is unacceptable, it can be changed as desired.

2.15 DRILLING PENETRATION RATES

Definition

Drilling penetration rate refers to the time rate with which a stated drilling method drills through a specific type of rock.

Selection

Stating specific drilling rates is extremely difficult because the rates are highly dependent upon weight on bit, RPM, torque, drilling fluid characteristics, shock, vibration, type of bit used, rock characteristics, etc. When rates are given they are usually stated in the form of a range. In this document rate ranges are given for rotary drilling, downhole motor drilling and coring for each of the seven different rock classes noted in DATABASE A, Section 1.1. In doing this, it is assumed that the correct bit type, fluids program, weight on bit, etc. have been chosen. However even this is not sufficient to produce accurate rates, because of the variation of rock characteristics from one piece to another. Thus although a series of penetration rates are given in Table B-15, they should be used with extreme caution. If the model user has any question about these rates, he should use his own judgement and change the rates accordingly.

Data Entry Requirements

The computer will automatically select the applicable penetration rates (Ft./Hr.) from Table B-15, for the drilling methods used in each zone based upon the geological classifications entered in Section 1.1, line 9, and the drilling method selected for each zone as noted in Section 1.4. If the values displayed on line 69 through 116 are unacceptable, they can be changed as desired.

DRILLING PENETRATION RATES ⁽¹⁾
(Estimated Ft./Hr.)

Table B-15

Drilling Method	Geologic Classification Number ⁽²⁾						
	1	2	3	4	5	6	7
● Rotary Drilling (Air)	40 and up	30 - 50	20 - 40	10 - 30	7 - 15	5 - 10	3 - 5
● Rotary Drilling (Mud)							
1 Rotary Bits	20 and up	10 - 20	8 - 15	6 - 10	3 - 6	2.5 - 5	1 - 3
2 Diamond Bits		7 - 15	6 - 12	5.5 - 9	4 - 7	3 - 5	1.5 - 4
3 PDC Bits	40 and up	20 - 50	10 - 30	5 - 25			
● Downhole Motor Drilling		20 - 30	16 - 20	8 - 15	5 - 10	2.5 - 5	1 - 3
● Core Drilling							
Conventional ⁽³⁾		5 - 10	5 - 10	3 - 8	3 - 5	3 - 5	1 - 3
Wireline		20 - 30	18 - 28	15 - 25	15 - 22	15 - 20	10 - 15

Note: (1) Drilling Penetration Rates are estimated and can vary widely depending upon RPM, wt. on bit, type of bit, geology, etc.. Thus, the above chart should not be used for direct comparative purposes, but only for selection of data for the computer model.

(2) Geological Classification correspond to those noted in Table A-1, DATABASE A, Section 1.1. for reference purposes:

Class 1 - Soft shale, clay, sand, salt.

Class 2 - Clay, red beds, sandstone, soft limestone, sandy shale, unconsolidated shales.

Class 3 - Sandy shales, sand, unconsolidated shales.

Class 4 - Shale, lime sand, shaley lime.

Class 5 - Dolomites, hard shale, hard limestone, hard sandy limestone.

Class 6 - Quartz, chert, dolomite.

Class 7 - Granite, tacomite, basalt.

(3) Rates are based on the use of diamond impregnated bits.

2.16 REAMING OPERATIONS

Definition

Reamers are rock cutting tools placed at various positions in the bottomhole assembly. Their primary functions are to maintain hole size, reduce dog leg severity and wipe out key seats. They are also used in conjunction with stabilizers to assist in maintaining a straight hole. Depending upon the purpose of the drilling operation, different types of reamers can be used.

Time

Reaming time is the time period used for operations concerned only with reaming the hole, such as reducing dog leg severity or wiping out key seats. It does not include the time when reamers are used in conjunction with drilling bits to maintain hole size, or with stabilizers to maintain hole straightness.

Reaming time will vary depending upon the type of rock involved, the volume of rock that must be removed, the type of reamer used, etc. Because of these variables the time required to ream one (1) foot of rock can vary sharply. Table B-16 illustrates a series of general time factors.

Cost

The cost of reaming equipment is accounted for in the average daily rental costs of the rig.

Data Entry Requirements

The computer will automatically select reaming rates (Ft./Hr.) from Table B-16 for those zones that utilize this operation, based on the rock classifications entered for each zone in Section 1.1, line 9, and on the operation use factor entered for each zone in Section 1.4, line 46. If the values displayed on lines 120 through 126 are unacceptable, they can be changed as desired.

REAMING OPERATION RATES (1)
(Estimated Ft./Hr.)

Table B-16

Operation	Geologic Classification Number (2)						
	1	2	3	4	5	6	7
Reaming	20 and up	10 - 20	8 - 15	6 - 10	3 - 6	2.5 - 5	1 - 3

Note: (1) The above stated reaming rates are estimated and will vary sharply depending upon the volume of rock to be removed, the type of rock, the type of reamer used, etc..

(2) Geological Classification correspond to those noted in Table A-1, DATA-BASE A, Section 1.1. For reference purposes:

- Class 1 - Soft shale, clay, sand, salt.
- Class 2 - Clay, red beds, sandstone, soft limestone, sandy shale, unconsolidated shales.
- Class 3 - Sandy shales, sand, unconsolidated shales.
- Class 4 - Shale, lime sand, shaley lime.
- Class 5 - Dolomites, hard shale, hard limestone, hard sandy limestone.
- Class 6 - Quartz, chert, dolomite.
- Class 7 - Granite, tacomite, basalt.

2.17 PIPE HANDLING OPERATIONS

Definition

Pipe handling is the operation of hoisting (tripping) the drill string in and/or out of the hole.

Time

Trip time varies with the depth of the hole. When stating trip time, one must define whether he is referring to a round trip (tripping in and out) or a one way trip (tripping in or out). In this model trip time refers to round trip. A table of average trip times follows:

Round Trip Time
(Estimated)

Table B-17

Hole Depth Range (Ft.)	Round Trip Time ⁽¹⁾ Total (Hrs.)
0 - 4,999	3.0
5,000 - 9,999	6.0
10,000 - 14,999	11.0
15,000 - 19,999	17.0
20,000 - 24,999	24.0
25,000 - 29,999	32.0
30,000 - 34,999	41.0
35,000 - 39,999	51.0
40,000 - 44,999	62.0
45,000 - 50,000	74.0

Note: (1) Round trip time is based on the average depth of the specific hole depth range noted.

Data Entry Requirements

The computer will enter the values (Hrs.) noted in Table B-17 as default values for lines 130 through 139. If these values are unacceptable, they can be changed as desired.

2.18 AUXILIARY OPERATIONS - SURVEYING

Definition

The maximum deviation the drilled hole is allowed to stray from the designed hole trajectory is usually defined by contractual agreement, state law, or some other governing document. This control applies to both vertical and deviated wells. To assure that the drilled hole stays within these limits, the drilling contractor periodically runs a directional survey tool into the hole to determine the drilled hole's angular direction. This operation is called "surveying". Surveys are usually run every 500 Ft. or less.

Time

Surveying operation time is composed of the time required to trip the instruments in and out of the hole, and the time required to rig up and rig down the tools. Actual time required to perform the survey is insignificant. Average total operation times for different hole depths are noted in Table B-18.

Cost

Surveying equipment is usually owned by the drilling contractor. Thus, the cost of the equipment is accounted for in the rig rate.

Data Entry Requirements

The computer will enter the value (Hrs.) noted in Table B-18 as default values for lines 142 through 151. If these values are unacceptable, they can be changed as desired.

SURVEYING OPERATION TIME
(Estimated)

Table B-18

Hole Depth Range (Ft.)	Operation Time (1) Total (Hrs.)
0 - 4,999	3.0
5,000 - 9,999	3.5
10,000 - 14,999	4.0
15,000 - 19,999	4.5
20,000 - 24,999	5.0
25,000 - 29,999	6.0
30,000 - 34,999	7.0
35,000 - 39,999	8.0
40,000 - 44,999	10.0
45,000 - 50,000	12.0

Note: (1) Operation time is based on the average depth of the specific hole depth range noted. It includes rig up, rig down, trip in, trip out, and surveying time.

2.19 AUXILIARY OPERATIONS - LOGGING

Definition

During the drilling operation, a number of different logs are taken. These include mud logs, electric logs, temperature logs, etc. Each monitors a specific series of drilling functions or geologic characteristics. The stated "Logging Operations" category is limited to those logging operations, that obtain from the borehole, basic, detailed information concerning its geological structures, its fluid systems and its physical characteristics. These properties include porosity, permeability, resistivity, etc. Electronic and nuclear radiation techniques are often used to obtain this data. Normally these logs are only taken after the well has reached bottom. In exploration wells, however, they may be taken several times.

Time

Logging operation time includes the time required to rig the equipment up and down, trip in and out of the hole, and take the necessary measurements in the hole. Approximations of the total time required to perform these operations is noted in Table B-19. These times can, however, vary considerably depending upon the scope and type of problems encountered and services desired.

Cost

When applicable logging costs include service charges, depth charges, operation charges, and special charges for mileage, crew, special equipment, etc. In addition, many of these charges vary based upon the number and type of logs desired. Thus log costs can vary considerably based upon what is desired. Table B-19 notes representative charges for logging services such as Gamma Ray, Audio Logging and High Resolution Temperature.

Data Entry Requirements

Using the data entered in Section 1.9, line 100 to determine the zones requiring logging operations, and Section 1.2, line 12 to determine the depth of the specific zones in question, select from Table B-19 the operating time (Hrs.) and cost (\$) of the number of logs desired. Enter this data in the appropriate cells on lines 155 through 164.

LOGGING OPERATION TIME AND COSTS
(Estimated)

Table B-19

Hole Depth Range (Ft.)	Operation Time (Hrs.)	Operation Cost/Run ⁽¹⁾			
		One Log (\$)	Two Logs (\$)	Three Logs (\$)	Four Logs (\$)
0 - 4,999	7	2,000	2,500	3,500	4,500
5,000 - 9,999	7 1/2	2,500	4,000	5,000	6,000
10,000 - 14,999	9 1/2	3,800	6,000	7,000	8,000
15,000 - 19,999	11 1/2	9,000	12,000	14,000	16,000
20,000 - 24,999	14	12,000	17,000	20,000	22,000
25,000 - 29,999	16 1/2	15,000	22,000	26,000	30,000
30,000 - 34,999	19	18,000	27,000	32,000	36,000
35,000 - 39,999	22	22,000	33,000	38,000	42,000
40,000 - 44,999	25 1/2	26,000	39,000	43,000	47,000
45,000 - 49,999	30	30,000	46,000	50,000	54,000

Notes: (1) Operation charges normally include a service charge, a logging charge, and a depth charge. The charges stated above are based upon the number of logs taken in a single run. They are substantially reduced to reflect the lower costs in 1985. The types of logs stated include radioactive logs, audio logs, gamma logs, flow logs, pressure logs, etc..

2.20 AUXILIARY OPERATIONS - OTHER

Definition

This category allows the use of any type of downhole data gathering operation other than surveying or logging. It is primarily intended as an area to enter into the program new or experimental types of operations.

Data Entry Requirements

The computer will enter a default value of zero (0) in the appropriate cells on lines 167 and 168. If the model user wishes to use a new downhole tool or component that qualifies for this category, he can enter its operation time per run on line 167 and the operation cost per run on line 168.

2.21 CORING OPERATIONS

Definition

Coring is a drilling technique whereby relatively large cylindrical samples of the geological structure that is being drilled are brought to the surface for examination. To obtain these cores, specialized bits are used to cut the core. A core barrel is used to retain the core and bring it to the surface after it has been cut.

These tools have been developed in a number of different ways, the most common being the conventional core barrel and the wire line core barrel. The conventional core barrel system uses a core bit and a core barrel that are attached directly to the drillstring. Thus to obtain the core, the entire drillstring and the attached core barrel must be tripped out of the hole. The wire line core barrel uses a system, whereby the coring bit is attached to the drillstring, but the core barrel is attached to a surface controlled wire line. To obtain the core barrel, the wire line is winched back to the surface. When the core bit wears out or must be changed, the entire drillstring must be tripped out. Wireline coring is faster, because it reduces the number of times the drill string must be tripped in and out of the hole. Core diameters are restricted to about 3 1/2 In. or less in wire line systems, whereas they can exceed more than 5 1/2 In. in conventional core barrel systems. Core barrel lengths vary depending upon the type of core barrel used.

● Core Barrel Lengths:

Conventional Core Barrels	-	30, 60 Ft.
Wireline Core Barrels	-	5, 10, 15, 20 Ft.

In addition to the two types of core barrels stated above, numerous specialized types are also available. These include pressurized core barrels that are used to maintain formation pressures in the core barrel, and rubber sleeve core barrels that are used to obtain cores from soft unconsolidated formations. Small cores can also be obtained from the walls of the well bore by use of specialized equipment.

Time

Time factors relate primarily to operational activities. If a conventional core barrel system is used, the main time factors are the attaching of the core barrel

to the drillstring, the tripping time, and the actual drilling time. If a wire line coring system is used, rig up and rig down time factors must be added. Except for drilling times, average time factors for each of these operations is listed below. Drilling time is automatically computed by the model.

Round Trip Time
(Estimated)

Table B-20

Hole Depth Range (Ft.)	Conventional Core Barrel (Hrs.)	Wireline Core Barrel (Hrs.)
0 - 4,999	3.00	1.00
5,000 - 9,999	6.00	1.25
10,000 - 14,999	11.00	1.50
15,000 - 19,999	17.00	2.50
20,000 - 29,999	28.00	4.00
30,000 - 50,000	57.00	9.00

● Operation Time:

- Core Drilling - Conventional
Change Drilling Tools - 5 Hrs.
- Core Drilling - Wireline
Rig Up/Down - 2 Hrs.
Change Drilling Tools - 5 Hrs.

Cost

Coring costs can be divided into two main areas: the cost of the coring bit, and the operation charges. The coring bit charges include the cost of the new bit, and the bit refund charge when it is returned to the coring equipment company. The refund charge varies with the physical condition of the returned bit.

Conventional core barrel operation charges include the daily rental costs of the core barrel and required special equipment, and supervisor charges. These charges are totaled and billed on a 24 hour day basis.

Wireline core barrels are normally sold to the drilling contractor. Thus component rental charges do not

apply. For purposes of this model, the following hourly charges have been developed.

● Hourly Charges:

Core Drilling - Conventional	- \$55.00/Hr.
Core Drilling - Wireline	- \$50.00/Hr.

Data Entry Requirements

Using the data entered in Sections 1.4, lines 35 and 40 to determine the types of coring operations used, select the length (Ft.) of the core barrels desired from the information stated above, and enter this data in the appropriate cells on lines 174 and/or 190. The remainder of the information required in Section 2.21 will be automatically entered by the computer, as default data. If any of the default values are unacceptable, they can be changed as desired.

2.22 CASING OPERATIONS

Definition

Casing operations include all activities involved in the actual running and setting of the casing in the hole.

Time

Time factors relate primarily to operational activities. They include rigup and rigdown operations, and general rig preparations prior to running the casing. These preparations include inspecting the casing, restringing the traveling block to handle the casing loads, changing the elevator, etc. Average hourly time factors involved in each of these operations are noted below.

● Operation Time:

Rig Up	-	2.00 Hrs.
Rig Down	-	2.00 Hrs.
Prepare to Run Casing	-	12.00 Hrs.

Casing Running Time (Avg. Hrs./1000')

36"	-	3.50 Hrs.
30"	-	3.50 Hrs.
20"	-	3.50 Hrs.
13 3/8"	-	3.00 Hrs.
10 3/4"	-	3.00 Hrs.
9 5/8"	-	3.00 Hrs.
7 5/8"	-	3.00 Hrs.
7"	-	3.00 Hrs.
5 1/2"	-	2.50 Hrs.
5"	-	2.50 Hrs.
4 1/2"	-	2.50 Hrs.
Liners	-	3.00 Hrs.

Cost

Cost factors are based on actual costs of casing and average cost of tools and services. Casing costs are based upon 100' lengths and are entered in Section 1.3, line 18. Tools and services include cost of scratchers, centralizers, special tools, etc.

● Tools, Services and Costs:

20" Casing	-	\$ 3,500
13 3/8" Casing	-	5,000
10 3/4" - 9 5/8" Casing	-	7,000
7 5/8" - 4 1/2" Casing	-	10,000
Liners	-	10,000

Data Entry Requirements

Considering the different size casings used in each zone, the computer will enter the appropriate values from the information stated above as default values for lines 203 through 235. If these values are unacceptable, they can be changed as desired.

2.23 CEMENTING OPERATIONS

Definition

Cementing operations include all activities involved in the actual cementing of the casing in the hole.

Time

Time factors relate primarily to operational activities. These activities include the rigging up and down of the various pieces of cementing equipment, the actual cementing operation, which varies with hole depth, waiting on the cement (W.O.C.) to harden, and testing the cement to determine if it has reached acceptable strength requirements. Average hourly time factors involved in each of these operations are noted below.

● Operation Time:

Rig Up	- 2 Hrs.
Rig Down	- 2 Hrs.
W.O.C./Testing	- 12 Hrs.

Cementing Time (Avg.)

0 - 4,999'	- 3 Hrs.
5,000 - 9,999'	- 7 Hrs.
10,000 - 14,999'	- 11 Hrs.
15,000 - 19,999'	- 16 Hrs.
20,000 - 24,999'	- 22 Hrs.
25,000 - 29,999'	- 29 Hrs.
30,000 - 34,999'	- 37 Hrs.
35,000 - 39,999'	- 46 Hrs.
40,000 - 44,999'	- 56 Hrs.
45,000 - 50,000'	- 67 Hrs.

Cost

Cost factors are based on estimated costs of cementing and average costs for tools and services. Cement costs are listed in Table A-13 DATABASE A, Section 1.8. No discounts are included.

Tools and services include the cost of cement plugs, spacers, special personnel, mileage charges, cementing operation charges, etc. These costs will vary with well depth. Estimated charges are noted in Table B-21.

TOOLS AND SERVICE COSTS
(Estimated)

Table B-21

Hole Depth Range (Ft.)	Tools and Service Costs (\$)
0 - 4,999	\$ 1,200
5,000 - 9,999'	\$ 1,700
10,000 - 14,999'	\$ 3,900
15,000 - 19,999'	\$ 8,600
20,000 - 24,999'	\$13,300
25,000 - 29,999'	\$18,200
30,000 - 34,999'	\$23,200
35,000 - 39,999'	\$28,600
40,000 - 44,999'	\$33,800
45,000 - 50,000'	\$39,000

Data Entry Requirements

The computer will enter the appropriate values from the information stated above as default values for lines 238 through 270. If these values are unacceptable, they can be changed as desired.

2.24 WELLHEAD EQUIPMENT AND INSTALLATION

Definition

The wellhead consists of the permanent surface equipment required to secure the various casing strings into position. This equipment consists of the casing head, casing hanger spools, seals, etc., as noted in Figure B-1.

Time

The average time required to remove and reattach the blowout preventer components, install the wellhead components and test the BOP is noted in Figure B-1. This can vary somewhat based upon the depth of the well and the size of the surface components.

Cost

Component costs vary depending upon the size of the casing string involved and the equipment used. Average costs for this type of equipment are noted in Table B-22.

Data Entry Requirements

The computer will enter time and cost values from Table B-22 as default values for lines 274 through 280. The cost values are for general purpose equipment. If these values are unacceptable they can be changed as desired.

Wellhead Assembly and Christmas Tree

Figure B-1

Ref: Cameron Iron Works

WELLHEAD EQUIPMENT
COST AND INSTALLATION DATA

Table B-22

	Casing Head		Casing Hangers		Spools ⁽¹⁾		Installation
Casing Size (In.)	General Purpose (\$)	Special ⁽²⁾ Purpose (\$)	General Purpose (\$)	Special ⁽²⁾ Purpose (\$)	General Purpose (\$)	Special ⁽²⁾ Purpose (\$)	Time (Hrs.)
4 1/2					6,200		20
5					7,400		20
5 1/2					7,400		20
7 5/8	1,800				7,600	9,100	20
9 5/8	2,000	3,200	3,300	4,000	10,400	14,300	20
10 3/4	2,000	3,200	3,300	4,000	14,500	16,100	20
13 3/8	3,000	7,500	7,000	8,300			20
20	6,500	8,000					15

Note: (1) Includes cost of required casing hanger.

(2) Used for high pressure, heavy loads, etc..

2.25 MAINTENANCE AND DRILLING PROBLEMS

Definition

A considerable amount of time is spent repairing the various rig components, reworking the hole, fishing, etc. Those activities that relate to rig problems, such as repair and welding, are defined as rig maintenance. Those activities that relate to the drilling activity, such as fishing and hole problems, are defined as drilling problems. All of these work elements are non-productive because during these operations, the drilling and/or completion of the well is not progressing forward. However, these non-productive operations do take place and must be accounted for from both a time and cost standpoint.

Time

Non-productive operations can vary from a small percentage of time to more than 50% of the total time the rig is over the hole. Time consumed by each of these two problem operations is normally indicated as a percentage (%) of the total zone operation time. Total(100%) zone operation time is the summation of operation times consumed by the drilling operation, the drilling problems time, and the maintenance time.

Cost

Paid time allotted the drilling contractor for maintenance and drilling problems is normally specified in the drilling contract. This factor, however, can vary based upon why the operation occurred. For this study, the non-drilling variable cost factor shall be applied to the entire time element used. This cost factor will be automatically calculated by the model.

Data Entry Requirements

Considering anticipated maintenance and/or drilling problems that could occur in each zone, determine the percentage of the total zone operation time that is consumed by each of these two operations. Enter this data (%) in the appropriate maintenance and drilling problem cells for each zone on lines 286 through 305. This data will be entered in the Misc. Column.

Note: The percentage numbers entered into the cells stated above must be in the form of whole numbers such as 26 or 30. Do not use a decimal such as .26 or .30.

FUNCTIONAL SPECIFICATIONS

DATABASE B

INTRODUCTION

The following pages contain The Functional Specifications for DATABASE B. In order to lessen the input requirements to the user, DRILTAC provides a routine which automatically selects default input values. The field headings or section headings on the following pages which are preceded by an asterisk (*) are the values which are NOT included in the Default Routine. Refer to the individual requirements to determine whether an input must be made.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Requirements
		<u>SECTION 2.1</u>
*8	Road Location and Site Preparation (Total \$)	1) Must be > 0 and <= 500,000
		<u>SECTION 2.2</u>
*10	Initiation (Total \$ & Hole Depth, Ft.)	
	Total \$	1) Must be > 0 and <= 50,000
	Hole Depth, Ft.	1) Must be > 0 and <= 200
		<u>SECTION 2.3</u>
12	Rig Movement (Avg. Hrs & Total \$)	1) Protected field - no entry
13	Demobilization Hrs.	1) Must be > 0 and <= 500
	\$	1) Must be > 0 and <= 100,000
14	Mobilization Hrs.	1) Must be > 0 and <= 250
	\$	1) Must be > 0 and <= 100,000
		* <u>SECTION 2.4</u>
16	Rig Operating Rates	1) Protected field - no entry
17	Day Rate (\$/Hr.)	1) Protected field - no entry
18	Standby/Nondrilling	1) Must be > 0 if Footage Rates (DBASE B, line 22) = 0. 2) Must be > = 0 and < = 500.
19	Rig With Pipe	1) Must be > 0 if Rig W/O Pipe (DBASE B, line 20) and Other (DBASE B, line 21) = 0. 2) Must be > = 0 and < = 500.
20	Rig Without Pipe	1) Must be > 0 if Rig With Pipe (DBASE B, line 19) and Other (DBASE B, line 21) = 0. 2) Must be > = 0 and < = 500.
21	Other	1) Must be > 0 if Rig With Pipe (DBASE B, line 19) and Other (DBASE B, line 21) = 0. 2) Must be > = 0 and < = 500.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Requirements
<u>SECTION 2.5</u>		
22	Footage Rates (\$/Ft.)	1) Must be > 0 if lines 18 - 21 (DBASE B) = 0. 2) Must be > = 0 and < = 500.
24	Fuel Consumption (Gal/Hr.)	1) Protected field - no entry
25	Standby Nondrilling	1) Must be > 0 if Standby/Nondrilling (DBASE B, line 18) > 0. 2) Must be > = 0 and < = 100.
26	Drilling	1) Must be > 0 if Standby/Nondrilling (DBASE B, line 18) > 0. 2) Must be > = 0 and < = 500.
27	Tripping	1) Protected field - no entry
28	0 - 4999'	1) Must be > 0 if line 18 (DBASE B) > 0. 2) Must be > = 0 and < = 100.
29	5000 - 9999'	1) Must be > 0 if line 18 (DBASE B) > 0 and Hole Depth from Surface (DBASE A, line 12) > = 5000. 2) Must be > = 0 and < = 200.
30	10000 - 14999'	1) Must be > 0 if line 18 (DBASE B) > 0 and Hole Depth from Surface (DBASE A, line 12) > = 10,000. 2) Must be > = 0 and < = 300.
31	15000 - 19999'	1) Must be > 0 if line 18 (DBASE B) > 0 and Hole Depth from Surface (DBASE A, line 12) > = 15,000. 2) Must be > = 0 and < = 400.
32	20000 - 29999'	1) Must be > 0 if line 18 (DBASE B) > 0 and Hole Depth from Surface (DBASE A, line 12) > = 20,000. 2) Must > = 0 and < = 500.
33	30000 - 50000'	1) Must be > 0 if line 18 (DBASE B) > 0 and Hole Depth from Surface (DBASE A, line 12) > = 30,000. 2) Must be > = 0 and < = 600.
<u>SECTION 2.6</u>		
35	Fuel Cost (\$/Gal)	1) Must be < = 5.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Requirements
		<u>SECTION 2.7</u>
37	Transportation & Miscellaneous Cost (\$/Hr.)	1) Must be ≤ 300 .
		<u>SECTION 2.8</u>
39	Rental Cost (\$/Hr.)	1) Must be ≤ 400 .
		<u>SECTION 2.9</u>
41	Special Tool Cost (\$/Hr.)	1) Protected field - no entry
42	Air Compressors & Auxiliary Equipment	1) Must be > 0 if Air Comp. & Aux. Equip. (DBASE A, line 23) > 0 (Any zone). 2) Must be ≥ 0 and ≤ 100 .
43	Air Hammers	1) Must be > 0 if Air Hammers (DBASE A, line 24) > 0 . (Any Zone) 2) Must be ≥ 0 and ≤ 500 .
44	Downhole Motors	1) Must be > 0 if any Downhole Motors (DBASE A, lines 25, 31, 36 and 41) > 0 . (Any zone). 2) Must be ≥ 0 and ≤ 500 .
45	Deviation Subs & Tools	1) Must be > 0 if any Deviation Sub & Tool (DBASE A, lines 32, 37 and 42) > 0 . (Any zone). 2) Must be ≥ 0 and ≤ 75 .
46	Telemetry Systems	1) Must be > 0 if any Telemetry Systems (DBASE A, lines 28, 33, 38 and 43) > 0 . (Any zone). 2) Must be ≥ 0 and ≤ 500 .
47	Other - Rotary Drilling - Air	1) Must be > 0 if Other (DBASE A, line 26) > 0 . 2) Must be ≥ 0 and ≤ 1000 .
48	Other - Rotary Drilling - Mud	1) Must be > 0 if Other (DBASE A, line 29) > 0 . 2) Must be ≥ 0 and ≤ 1000 .

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Requirements
49	Other - Downhole Motor - Mud	1) Must be > 0 if Other (DBASE A, line 34) > 0. 2) Must be > = 0 and < = 1000.
50	Other - Core Drilling - Conv.	1) Must be > 0 if Other (DBASE A, line 39) > 0. 2) Must be > = 0 and < = 1000.
51	Other - Core Drilling - Wireline	1) Must be > 0 if Other (DBASE A, line 44) > 0. 2) Must be > = 0 and < = 1000.
52	Other - Other	1) Must be > 0 if Other (DBASE A, line 44) > 0.
<u>SECTION 2.10</u>		
54	Supervision Cost (\$/Hr.)	1) Must be > 0 and < = 1000.
<u>SECTION 2.11</u>		
56	Condition Drilling Fluids (Avg. Hrs.)	1) Must be > 0 if Surface Sys. Vol. (DBASE A, line 78) > 0. 2) Must be > = 0 and < = 10.
<u>SECTION 2.12</u>		
58	Water Cost (Total \$)	1) Protected field - no entry
59	Purchase Cost	1) Must be > 0 if Surface Sys. Vol. (DBASE A, line 78) > 0. 2) Must be > = 0 and < = 20,000.
60	Disposal Cost	1) Must be > 0 if Surface Sys. Vol. (DBASE A, line 78) > 0.
<u>SECTION 2.13</u>		
62	Bit Change (Avg. Hrs.)	1) Must be > 0 and < = 10.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Requirements
		<u>SECTION 2.14</u>
64	Bottomhole Assembly (BHA) Change (Avg. Hrs.)	1) Must be > 0 and < = 20.
		<u>SECTION 2.15</u>
67	Drilling Penetration Rate (Ft./Hr.)	1) Protected field - no entry
68	Zone A	1) Protected field - no entry
69	Rotary Drilling - Air	1) Must be > 0 if Rotary Drilling - Air (DBASE A, line 22) > 0. (Zone A). 2) Must be > = 0 and < = 100.
70	Rotary Drilling - Mud	1) Must be > 0 if Rotary Drilling - Mud (DBASE A, line 27) > 0. (Zone A). 2) Must be > = 0 and < = 100.
71	Downhole Motor Drilling	1) Must be > 0 if Downhole Motor - Mud (DBASE A, line 30) > 0. (Zone A). 2) Must be > = 0 and < = 100.
72	Core Drilling - Conventional	1) Must be > 0 if Core Drilling - Conventional (DBASE A, line 35 > 0. (Zone A). 2) Must be > = 0 and < = 100.
73	Core Drilling - Wireline	1) Must be > 0 if Core Drilling - Wireline (DBASE A, line 40) > 0. (Zone A). 2) Must be > = 0 and < = 100.
74	Other	1) Must be > 0 if Other (DBASE A, line 45) > 0. (Zone A). 2) Must be > = 0 and < = 200.
75	Zone B	1) Protected field - no entry
76	Rotary Drilling - Air	1) Must be > 0 if Rotary Drilling - Air (DBASE A, line 22) > 0. (Zone B). 2) Must be > = 0 and < = 100.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Requirements
77	Rotary Drilling - Mud	1) Must be > 0 if Rotary Drilling - Mud (DBASE A, line 27) > 0. (Zone B). 2) Must be > = 0 and < = 100.
78	Downhole Motor Drilling	1) Must be > 0 if Downhole Motor - Mud (DBASE A, line 30) > 0. (Zone B). 2) Must be > = 0 and < = 100.
79	Core Drilling - Conventional	1) Must be > 0 if Core Drilling - Conventional (DBASE A, line 35) > 0. (Zone B). 2) Must be > = 0 and < = 100.
80	Core Drilling - Wireline	1) Must be > 0 if Core Drilling - Wireline (DBASE A, line 40) > 0. (Zone B). 2) Must be > = 0 and < = 100.
81	Other	1) Must be > 0 if Other (DBASE A, line 45) > 0. (Zone B). 2) Must be > = 0 and < = 200.
82	Zone C	1) Protected field - no entry
83	Rotary Drilling - Air	1) Must be > 0 if Rotary Drilling - Air (DBASE A, line 22) > 0. (Zone C). 2) Must be > = 0 and < = 100.
84	Rotary Drilling - Mud	1) Must be > 0 if Rotary Drilling - Mud (DBASE A, line 27) > 0. (Zone C). 2) Must be > = 0 and < = 100.
85	Downhole Motor Drilling	1) Must be > 0 if Downhole Motor - Mud (DBASE A, line 30) > 0. (Zone C). 2) Must be > = 0 and < = 100.
86	Core Drilling - Conventional	1) Must be > 0 if Core Drilling - Conventional (DBASE A, line 35) > 0. (Zone C). 2) Must be > = 0 and < = 100.
87	Core Drilling - Wireline	1) Must be > 0 if Core Drilling - Wireline (DBASE A, line 40) > 0. (Zone C). 2) Must be > = 0 and < = 100.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Requirements
88	Other	1) Must be > 0 if Other (DBASE A, line 45) > 0. (Zone C). 2) Must be > = 0 and < = 200.
89	Zone D	1) Protected field - no entry
90	Rotary Drilling - Air	1) Must be > 0 if Rotary Drilling - Air (DBASE A, line 22) > 0. (Zone D). 2) Must be > = 0 and < = 100.
91	Rotary Drilling - Mud	1) Must be > 0 if Rotary Drilling - Mud (DBASE A, line 27) > 0. (Zone D). 2) Must be > = 0 and < = 100.
92	Downhole Motor Drilling	1) Must be > 0 if Downhole Motor - Mud (DBASE A, line 30) > 0. (Zone D). 2) Must be > = 0 and < = 100.
93	Core Drilling - Conventional	1) Must be > 0 if Core Drilling - Conventional (DBASE A, line 35) > 0. (Zone D). 2) Must be > = 0 and < = 100.
94	Core Drilling - Wireline	1) Must be > 0 if Core Drilling - Wireline (DBASE A, line 40) > 0. (Zone D). 2) Must be > = 0 and < = 100.
95	Other	1) Must be > 0 if Other (DBASE A, line 45) > 0. (Zone D). 2) Must be > = 0 and < = 200.
96	Zone E	1) Protected field - no entry
97	Rotary Drilling - Air	1) Must be > 0 if Rotary Drilling - Air (DBASE A, line 22) > 0. (Zone E). 2) Must be > = 0 and < = 100.
98	Rotary Drilling - Mud	1) Must be > 0 if Rotary Drilling - Mud (DBASE A, line 27) > 0. (Zone E). 2) Must be > = 0 and < = 100.
99	Downhole Motor Drilling	1) Must be > 0 if Downhole Motor - Mud (DBASE A, line 30) > 0. (Zone E). 2) Must be > = 0 and < = 100.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Requirements
100	Core Drilling - Conventional	1) Must be > 0 if Core Drilling - Conventional (DBASE A, line 35) > 0. (Zone E). 2) Must be > = 0 and < = 100.
101	Core Drilling - Wireline	1) Must be > 0 if Core Drilling - Wireline (DBASE A, line 40) > 0. (Zone E). 2) Must be > = 0 and < = 100.
102	Other	1) Must be > 0 if Other (DBASE A, line 45) > 0. (Zone E). 2) Must be > = 0 and < = 200.
103	Zone F	1) Protected field - no entry
104	Rotary Drilling - Air	1) Must be > 0 if Rotary Drilling - Air (DBASE A, line 22) > 0. (Zone F). 2) Must be > = 0 and < = 100.
105	Rotary Drilling - Mud	1) Must be > 0 if Rotary Drilling - Mud (DBASE A, line 27) > 0. (Zone F). 2) Must be > = 0 and < = 100.
106	Downhole Motor Drilling	1) Must be > 0 if Downhole Motor - Mud (DBASE A, line 30) > 0. (Zone F). 2) Must be > = 0 and < = 100.
107	Core Drilling - Conventional	1) Must be > 0 if Core Drilling - Conventional (DBASE A, line 35) > 0. (Zone F). 2) Must be > = 0 and < = 100.
108	Core Drilling - Wireline	1) Must be > 0 if Core Drilling - Wireline (DBASE A, line 40) > 0. (Zone F). 2) Must be > = 0 and < = 100.
109	Other	1) Must be > 0 if Other (DBASE A, line 45) > 0. (Zone F). 2) Must be > = 0 and < = 200.
110	Zone G	1) Protected field - no entry
111	Rotary Drilling - Air	1) Must be > 0 if Rotary Drilling - Air (DBASE A, line 22) > 0. (Zone G). 2) Must be > = 0 and < = 100.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Requirements
112	Rotary Drilling - Mud	1) Must be > 0 if Rotary Drilling - Mud (DBASE A, line 27) > 0. (Zone G). 2) Must be > = 0 and < = 100.
113	Downhole Motor Drilling	1) Must be > 0 if Downhole Motor - Mud (DBASE A, line 30) > 0. (Zone G). 2) Must be > = 0 and < = 100.
114	Core Drilling - Conventional	1) Must be > 0 if Core Drilling - Conventional (DBASE A, line 35) > 0. (Zone G). 2) Must be > = 0 and < = 100.
115	Core Drilling - Wireline	1) Must be > 0 if Core Drilling - Wireline (DBASE A, line 40) > 0. (Zone G). 2) Must be > = 0 and < = 100.
116	Other	1) Must be > 0 if Other (DBASE A, line 45) > 0. (Zone G). 2) Must be > = 0 and < = 200.
<u>SECTION 2.16</u>		
118	Reaming Operations	1) Protected field - no entry
119	Reaming Rates (Ft./Hr.)	1) Protected field - no entry
120	Zone A	1) Must be > 0 if Reaming (DBASE A, line 46) > 0. (Zone A). 2) Must > = 0 and < = 100.
121	Zone B	1) Must be > 0 if Reaming (DBASE A, line 46) > 0. (Zone B). 2) Must be > = 0 and < = 100.
122	Zone C	1) Must be > 0 if Reaming (DBASE A, line 46) > 0. (Zone C). 2) Must be > = 0 and < = 100.
123	Zone D	1) Must be > 0 if Reaming (DBASE A, line 46) > 0. (Zone D). 2) Must be > = 0 and < = 100.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Requirements
124	Zone E	1) Must be > 0 if Reaming (DBASE A, line 46) > 0. (Zone E). 2) Must be > = 0 and < = 100.
125	Zone F	1) Must be > 0 if Reaming (DBASE A, line 46) > 0. (Zone F). 2) Must be > = 0 and < = 100.
126	Zone G	1) Must be > 0 if Reaming (DBASE A, line 46) > 0. (Zone G). 2) Must be > = 0 and < = 100.
<u>SECTION 2.17</u>		
128	Pipe Handling Operations	1) Protected field - no entry
129	Round Trip (Avg. Hrs./Rnd. Trip)	1) Protected field - no entry
130	0 - 4999'	1) Must be > 0 if Hole Depth from Surface (DBASE A, line 12) > 0. 2) Must be > 0 and < = 10.
131	5000 - 9999'	1) Must be > 0 if Hole Depth from Surface (DBASE A, line 12) > 5000. 2) Must be > = 0 and < = 10.
132	10000 - 14999'	1) Must be > 0 if Hole Depth from Surface (DBASE A, line 12) > = 10000. 2) Must be > = 0 and < = 20.
133	15000 - 19999'	1) Must be > = if Hole Depth from Surface (DBASE A, line 12) > = 15000. 2) Must be > = 0 and < = 30.
134	20000 - 24999'	1) Must be > 0 if Hole Depth from Surface (DBASE A, line 12) > = 20000. 2) Must be > = 0 and < = 40.
135	25000 - 29999'	1) Must be > 0 if Hole Depth from Surface (DBASE A, line 12) > = 25000. 2) Must be > = 0 and < = 50.
136	30000 - 34999'	1) Must be > 0 if Hole Depth from Surface (DBASE A, line 12) > = 30000. 2) Must be > = 0 and < = 50.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Requirements
137	35000 - 39999'	1) Must be > 0 if Hole Depth from Surface (DBASE A, line 12) > = 35000. 2) Must be > = 0 and < = 70.
138	40000 - 44999'	1) Must be > 0 if Hole Depth from Surface (DBASE A, line 12) > = 40000. 2) Must be > = 0 and < = 80.
139	45000 - 50000'	1) Must be > 0 if Hole Depth from Surface (DBASE A, line 12) > = 45000. 2) Must be > = 0 and < = 90.
<u>SECTION 2.18</u>		
141	Auxiliary Operations Surv. (Avg. Hrs./Run)	1) Protected field - no entry
142	0 - 4999'	1) Must be > 0 if Hole Depth from Surface (DBASE A, line 12) > 0. 2) Must be > = 0 and < = 20.
143	5000 - 9999'	1) Must be > 0 if Hole Depth from Surface (DBASE A, line 12) > 5000. 2) Must be > = 0 and < = 20.
144	10000 - 14999'	1) Must be > 0 if Hole Depth from Surface (DBASE A, line 12) > = 10000. 2) Must be > = 0 and < = 20.
145	15000 - 19999'	1) Must be > = 0 if Hole Depth from Surface (DBASE A, line 12) > = 15000. 2) Must be > = 0 and < = 20.
146	20,000 - 24,999'	1) Must be > 0 if Hole Depth from Surface (DBASE A, line 12) > = 20000. 2) Must be > = 0 and < = 20.
147	25,000 - 29,999'	1) Must be > 0 if Hole Depth from Surface (DBASE A, line 12) > = 25000. 2) Must be > = 0 and < = 20.
148	30,000 - 34,999'	1) Must be > 0 if Hole Depth from Surface (DBASE A, line 12) > = 30000. 2) Must be > = 0 and < = 20.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Specifications
149	35000 - 39999'	1) Must be > 0 if Hole Depth from Surface (DBASE A, line 12) > = 35000. 2) Must be > = 0 and < = 20.
150	40000 - 44999'	1) Must be > 0 if Hole Depth from Surface (DBASE A, line 12) > = 40000. 2) Must be > = 0 and < = 20.
151	45000 - 50000'	1) Must be > 0 if Hole Depth from Surface (DBASE A, line 12) > = 45000. 2) Must be > = 0 and < = 20.
<u>SECTION 2.19</u>		
153	Auxiliary Operations Logging	1) Protected field - no entry
154	Log Time (Avg. Hrs./Run) & Cost (\$/Run)	1) Protected field - no entry
155	0 - 4999' Operation Time (Hrs.)	1) Must be > 0 if Logging (DBASE A, line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 50.
	Operation Cost (\$)	1) Must be > 0 if Logging (DBASE A, line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 50000.
156	5000 - 9999' Operation Time (Hrs.)	1) Must be > 0 if Logging (DBASE A, line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 50.
	Operation Cost (\$)	1) Must be > 0 if Logging (DBASE A, line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 50000.
157	10000 - 14999' Operation Time (Hrs.)	1) Must be > 0 if Logging (DBASE A, line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 50.
	Operation Cost (\$)	1) Must be > 0 if Logging (DBASE A, line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 50000.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Requirements
158	15000 - 19999' Operation Time (Hrs.)	1) Must be > 0 if Logging (DBASE A. line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 50.
	Operation Cost (\$)	1) Must be > 0 if Logging (DBASE A, line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 50000.
159	20000 - 24999' Operation Time (Hrs.)	1) Must be > 0 if Logging (DBASE A. line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 50.
	Operation Cost (\$)	1) Must be > 0 if Logging (DBASE A, line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 50000.
160	25000 - 29999' Operation Time (Hrs.)	1) Must be > 0 if Logging (DBASE A. line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 100.
	Operation Cost (\$)	1) Must be > 0 if Logging (DBASE A, line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 100000.
161	30000 - 34999' Operation Time (Hrs.)	1) Must be > 0 if Logging (DBASE A. line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 100.
	Operation Cost (\$)	1) Must be > 0 if Logging (DBASE A, line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 100000.
162	35000 - 39999' Operation Time (Hrs.)	1) Must be > 0 if Logging (DBASE A. line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 100.
	Operation Cost (\$)	1) Must be > 0 if Logging (DBASE A, line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 100000.
163	40000 - 44999' Operation Time (Hrs.)	1) Must be > 0 if Logging (DBASE A. line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 100.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Specification
	Operation Cost (\$)	1) Must be > 0 if Logging (DBASE A, line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 100000.
164	45000 - 50000' Operation Time (Hrs.)	1) Must be > 0 if Logging (DBASE A, line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 100.
	Operation Cost (\$)	1) Must be > 0 if Logging (DBASE A, line 100) > 0 for this depth interval. 2) Must be > = 0 and < = 100000.
		<u>*SECTION 2.20</u>
166	Auxiliary Operations Other	1) Protected field - no entry
167	Operation Time Per Run (Avg. Hrs./Run)	1) Must be > 0 if Other (DBASE A, line 101) > 0 for any zone. 2) Must be > = 0 and < = 250.
168	Operation Cost per Run (Avg. \$/Run)	1) Must be > 0 if Other (DBASE A, line 101) > 0 for any zone. 2) Must be > = 0 and < = 250,000.
		<u>SECTION 2.21</u>
170	Coring Operations	1) Protected field - no entry
171	Core Drilling - Conventional	1) Protected field - no entry
172	Coring Operation Charges (\$/Hr.)	1) Must be > 0 if Core Drilling - Conventional (DBASE A, line 35) > 0 for any zone. 2) Must be > = 0 and < = 100.
173	Change Drilling Tools (Avg. Hrs.)	1) Must be > 0 if Core Drilling - Conventional (DBASE A, line 35) > 0 for any zone. 2) Must be > = 0 and < = 20.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Specification
*174	Core Barrel Length (Ft.)	1) Must be > 0 if Core Drilling - Conventional (DBASE A, line 35) > 0 for any zone. 2) Must be > = 0 and < = 100.
175	Trip In/Out (Avg. Hrs.)	1) Protected field - no entry
176	0 - 4999'	1) Must be > 0 if Core Drilling - Conventional (DBASE A, line 35) > 0 for this depth interval. 2) Must be > = 0 and < = 10.
177	5000 - 9999'	1) Must be > 0 if Core Drilling - Conventional (DBASE A, line 35) > 0 for this depth interval. 2) Must be > = 0 and < = 10.
178	10000 - 14999'	1) Must be > 0 if Core Drilling - Conventional (DBASE A, line 35) > 0 for this depth interval. 2) Must be > = 0 and < = 15.
179	15000 - 19999'	1) Must be > 0 if Core Drilling - Conventional (DBASE A, line 35) > 0 for this depth interval. 2) Must be > = 0 and < = 25.
180	20000 - 29999'	1) Must be > 0 if Core Drilling - Conventional (DBASE A, line 35) > 0 for this depth interval. 2) Must be > = 0 and < = 40.
181	30000 - 50000'	1) Must be > 0 if Core Drilling - Conventional (DBASE A, line 35) > 0 for this depth interval. 2) Must be > = 0 and < = 65.
186	Core Drilling Wireline	1) Protected field - no entry
187	Coring Operation Charges (\$/Hr.)	1) Must be > 0 if Core Drilling - Wireline (DBASE A, line 40) > 0 for this depth interval. 2) Must be > = 0 and < = 100.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Specifications
188	Rig Up/Down (Avg. Hrs.)	1) Must be > 0 if Core Drilling - Wireline (DATABASE A, line 40) > 0 for this depth interval. 2) Must be > = 0 and < = 5.
189	Change Drilling Tools (Avg. Hrs.)	1) Must be > 0 if Core Drilling - Wireline (DBASE A, line 40) > 0 for this depth interval. 2) Must be > = 0 and < = 10.
*190	Core Barrel Length (Ft.)	1) Must be > 0 if Core Drilling Wireline (DATABASE A, line 40) > 0 for this depth interval. 2) Must be > = 0 and < = 50.
191	Trip In/Out (Avg. Hrs.)	1) Protected field - no entry
192	0 - 4999'	1) Must be > 0 if Core Drilling - Wireline (DBASE A, line 40) > 0 for this depth interval. 2) Must be > = 0 and < = 3.
193	5000 - 9999'	1) Must be > 0 if Core Drilling - Wireline (DBASE A, line 40) > 0 for this depth interval. 2) Must be > = 0 and < = 4.
194	10000 - 14999'	1) Must be > 0 if Core Drilling - Wireline (DBASE A, line 40) > 0 for this depth interval. 2) Must be > = 0 and < = 5.
195	15000 - 19999'	1) Must be > 0 if Core Drilling - Wireline (DBASE A, line 40) > 0 for this depth interval. 2) Must be > = 0 and < = 9.
196	20000 - 29999'	1) Must be > 0 if Core Drilling - Wireline (DBASE A, line 40) > 0 for this depth interval. 2) Must be > = 0 and < = 12.
197	30000 - 50000'	1) Must be > 0 if Core Drilling - Wireline (DBASE A, line 40) > 0 for this depth interval. 2) Must be > = 0 and < = 20.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Specifications
		<u>SECTION 2.22</u>
202	Casing Operations	1) Protected field - no entry
203	Rig Up (Avg. Hrs.)	1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0 for any zone. 2) Must be > = 0 and < = 5.
204	Rig Down (Avg. Hrs.)	1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0 for any zone. 2) Must be > = 0 and < = 5.
205	Prepare to Run Casing (Avg. Hrs.)	1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0 for any zone. 2) Must be > = 0 and < = 24.
*206	Other (Avg. Hrs. & Total Cost (\$))	1) User selected - no restrictions
208	Zone A	1) Protected field - no entry
209	Casing Run Time (Avg. Hrs./1000')	1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0. (Zone A). 2) Must be > = 0 and < = 7.
210	Tools & Svcs. (Total Cost (\$))	1) User selected. 2) Must be > = 0 and < = 20,000.
211	Other (Avg. Hrs. & Total Cost (\$))	1) User Selected.
212	Zone B	1) Protected field - no entry
213	Casing Run Time (Avg. Hrs./1000')	1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0. (Zone B). 2) Must be > = 0 and < = 7.
214	Tools & Svcs. (Total Cost (\$))	1) User selected. 2) Must be > = 0 and < = 20,000.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Specifications
215	Other (Avg. Hrs. & Total Cost (\$))	1) User selected - no limits
216	Zone C	1) Protected field - no entry
217	Casing Run Time (Avg. Hrs./1000')	1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0. (Zone C). 2) Must be > = 0 and < = 7.
218	Tools & Svcs. (Total Cost (\$))	1) User selected. 2) Must be > = 0 and < = 20,000.
219	Other (Avg. Hrs. & Total Cost (\$))	1) User selected - no limits
220	Zone D	1) Protected field - no entry
221	Casing Run Time (Avg. Hrs./1000')	1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0. (Zone A). 2) Must be > = 0 and < = 7.
222	Tools & Svcs. (Total Cost (\$))	1) User selected. 2) Must be > = 0 and < = 20,000.
223	Other (Avg. Hrs. & Total Cost (\$))	1) User selected - no limits
224	Zone E	1) Protected field - no entry
225	Casing Run Time (Avg. Hrs./1000')	1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0. (Zone E). 2) Must be > = 0 and < = 7.
226	Tools & Svcs. (Total Cost (\$))	1) User selected. 2) Must be > = 0 and < = 20,000.
227	Other (Avg. Hrs. & Total Cost (\$))	1) User selected - no limits

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Specifications
228	Zone F	1) Protected field - no entry
229	Casing Run Time (Avg. Hrs./1000')	1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0. (Zone F). 2) Must be > = 0 and < = 7.
230	Tools & Svcs. (Total Cost (\$))	1) User selected. 2) Must be > = 0 and < = 20,000.
231	Other (Avg. Hrs. & Total Cost (\$))	1) User selected - no limits
232	Zone G	1) Protected field - no entry
233	Casing Run Time (Avg. Hrs./1000')	1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0. (Zone G). 2) Must be > = 0 and < = 7.
234	Tools & Svcs. (Total Cost (\$))	1) User selected. 2) Must be > = 0 and < = 20,000.
235	Other (Avg. Hrs. & Total Cost (\$))	1) User selected - no limits
<u>SECTION 2.23</u>		
237	Cementing Operations	1) Protected field - no entry
238	Rig Up (Avg. Hrs.)	1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0 for any zone. 2) Must be > = 0 and < = 5. 3) May be entered on an "as needed" basis. (Casing is not required when cementing but cementing is required while casing.)

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Requirements
239	Rig Down (Avg. Hrs.)	<ol style="list-style-type: none"> 1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0 for any zone. 2) Must be > = 0 and < = 5. 3) May be entered on an "as needed" basis. (Casing is not required when cementing but cementing is required while casing.)
240	W.D.C./Test (Avg. Hrs.)	<ol style="list-style-type: none"> 1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0 for any zone. 2) Must be > = 0 and < = 24. 3) May be used as desired.
*241	Other (Avg. Hrs. & Total Cost (\$))	<ol style="list-style-type: none"> 1) User selected - no limits
243	Zone A	<ol style="list-style-type: none"> 1) Protected field - no entry
244	Cementing Time (Avg. Hrs.)	<ol style="list-style-type: none"> 1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0. (Zone A). 2) Must be > = 0 and < = 100.
245	Tools & Svcs. (Total Cost (\$))	<ol style="list-style-type: none"> 1) User selected 2) Must be > = 0 and < = 70,000.
*246	Other (Avg. Hrs. & Total Cost (\$))	<ol style="list-style-type: none"> 1) User selected - no limits.
247	Zone B	<ol style="list-style-type: none"> 1) Protected field - no entry
248	Cementing Time (Avg. Hrs.)	<ol style="list-style-type: none"> 1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0. (Zone B). 2) Must be > = 0 and < = 100.
249	Tools & Svcs. (Total Cost (\$))	<ol style="list-style-type: none"> 1) User selected 2) Must be > = 0 and < = 70,000.
*250	Other (Avg. Hrs. & Total Cost (\$))	<ol style="list-style-type: none"> 1) User selected - no limits.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Requirements
251	Zone C	1) Protected field - no entry
252	Cementing Time (Avg. Hrs.)	1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0. (Zone C). 2) Must be > = 0 and < = 100.
253	Tools & Svcs. (Total Cost (\$))	1) User selected 2) Must be > = 0 and < = 70,000.
*254	Other (Avg. Hrs. & Total Cost (\$))	1) User selected - no limits.
255	Zone D	1) Protected field - no entry
256	Cementing Time (Avg. Hrs.)	1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0. (Zone D). 2) Must be > = 0 and < = 100.
257	Tools & Svcs. (Total Cost (\$))	1) User selected 2) Must be > = 0 and < = 70,000.
*258	Other (Avg. Hrs. & Total Cost (\$))	1) User selected - no limits.
259	Zone E	1) Protected field - no entry
260	Cementing Time (Avg. Hrs.)	1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0. (Zone E). 2) Must be > = 0 and < = 100.
261	Tools & Svcs. (Total Cost (\$))	1) User selected 2) Must be > = 0 and < = 70,000.
*262	Other (Avg. Hrs. & Total Cost (\$))	1) User selected - no limits.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Requirements
263	Zone F	1) Protected field - no entry
264	Cementing Time (Avg. Hrs.)	1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0. (Zone F). 2) Must be > = 0 and < = 100.
265	Tools & Svcs. (Total Cost (\$))	1) User selected 2) Must be > = 0 and < = 70,000.
*266	Other (Avg. Hrs. & Total Cost (\$))	1) User selected - no limits.
267	Zone G	1) Protected field - no entry
268	Cementing Time (Avg. Hrs.)	1) Must be > 0 if Casing/Liner Length (DBASE A, line 16) > 0. (Zone G). 2) Must be > = 0 and < = 100.
269	Tools & Svcs. (Total Cost (\$))	1) User selected 2) Must be > = 0 and < = 70,000.
*270	Other (Avg. Hrs. & Total Cost (\$))	1) User selected - no limits.
<u>SECTION 2.24</u>		
272	Wellhead Equipment and Installation	1) Protected field - no entry
273	Install Time & Equip. Cost (Total Hrs./(\$))	1) Protected field - no entry
274	Zone A Oper. Time (Hrs.)	1) Must be > 0 if performing this operation in Zone A. 2) Must be > = 0 and < = 48.
	Oper. Time (\$)	1) Must be > 0 if performing this operation in Zone A. 2) Must be > = 0 and < = 75,000.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Requirements
275	Zone B Oper. Time (Hrs.)	1) Must be > 0 if performing this operation in Zone B. 2) Must be > = 0 and < = 48.
	Oper. Time (\$)	1) Must be > 0 if performing this operation in Zone B. 2) Must be > = 0 and < = 75,000.
276	Zone C Oper. Time (Hrs.)	1) Must be > 0 if performing this operation in Zone C. 2) Must be > = 0 and < = 48.
	Oper. Time (\$)	1) Must be > 0 if performing this operation in Zone C. 2) Must be > = 0 and < = 75,000.
277	Zone D Oper. Time (Hrs.)	1) Must be > 0 if performing this operation in Zone D. 2) Must be > = 0 and < = 48.
	Oper. Time (\$)	1) Must be > 0 if performing this operation in Zone D. 2) Must be > = 0 and < = 75,000.
278	Zone E Oper. Time (Hrs.)	1) Must be > 0 if performing this operation in Zone E. 2) Must be > = 0 and < = 48.
	Oper. Time (\$)	1) Must be > 0 if performing this operation in Zone E. 2) Must be > = 0 and < = 75,000.
279	Zone F Oper. Time (Hrs.)	1) Must be > 0 if performing this operation in Zone F. 2) Must be > = 0 and < = 48.
	Oper. Time (\$)	1) Must be > 0 if performing this operation in Zone F. 2) Must be > = 0 and < = 75,000.

FUNCTIONAL SPECIFICATIONS
DATABASE B

Line No.	Field Heading	Input Specification
280	Zone G Oper. Time (Hrs.)	1) Must be > 0 if performing this operation in Zone G. 2) Must be > = 0 and < = 48.
	Oper. Time (\$)	1) Must be > 0 if performing this operation in Zone G. 2) Must be > = 0 and < = 75,000.
		*SECTION 2.25
283	Maint./Dlg. Problem	1) Protected field - no entry.
284	Percent Aone Time (%)	1) Protected field - no entry.
285	Zone A	1) Protected field - no entry.
286	Maintenance	1) User selected. 2) Must be >= 0 and <= 100.
287	Drilling Problem	1) User selected. 2) Must be >= 0 and <= 100.
288	Zone B	1) Protected field - no entry.
289	Maintenance	1) User selected. 2) Must be >= 0 and <= 100.
290	Drilling Problem	1) User selected. 2) Must be >= 0 and <= 100.
291	Zone C	1) Protected field - no entry.
292	Maintenance	1) User selected. 2) Must be >= 0 and <= 100.
293	Drilling Problem	1) User selected. 2) Must be >= 0 and <= 100.
294	Zone D	1) Protected field - no entry.
295	Maintenance	1) User selected. 2) Must be >= 0 and <= 100.
296	Drilling Problem	1) User selected. 2) Must be >= 0 and <= 100.

IV.

DRILTAC DISPLAY AREAS

DATABASE A.								DATABASE B.			
WELL DESIGN AND DRILLING INSTRUCTIONS								OPERATION TIME AND COST DATA			
Requirement	Zone A	Zone B	Zone C	Zone D	Zone E	Zone F	Zone G	Operation	Op Time (Hrs.)	Oper. Cost (\$)	Misc.
8 1.1 Geologic Evaluation								8 2.1 Road Location and Site Prep. (Total \$)			
9 Classification Number								9			
10								10 2.2 Initiation (Total \$ & Hole Depth, Ft.)			
11 1.2 Well Geometry								11			
12 Hole Depth From Surface (Ft.)								12 2.3 Rig Movement (Avg. Hrs. & Total \$)			
13 Hole Diam. (In.)								13 Demobilization			
14								14 Mobilization			
15 1.3 Casing Program								15			
16 Casing/Liner Length (Ft.)								16 2.4 Rig Operating Rates			
17 Casing/Liner Diam. (In.)								17 Day Rate (\$/Hr.)			
18 Unit Cost (\$/100')								18 Standby/Nondrilling			
19								19 Rig With Pipe			
20 1.4 Drilling Techniques & Equip. Used								20 Rig Without Pipe			
21 Drilling Method (% Time)								21 Other			
22 Rotary Drilling-Air								22 Footage Rates (\$/Ft.)			
23 Air Comp. & Aux. Equip.								23			
24 Air Hammers								24 2.5 Fuel Consumption (Gal./Hr.)			
25 Downhole Motors								25 Standby/Nondrilling			
26 Other								26 Drilling			
27 Rotary Drilling-Mud								27 Tripping			
28 Telemetry Systems								28 0-4999'			
29 Other								29 5000-9999'			
30 Downhole Motor-Mud								30 10000-14999'			
31 Downhole Motors								31 15000-19999'			
32 Deviation Sub & Tools								32 20000-29999'			
33 Telemetry Systems								33 30000-50000'			
34 Other								34			
35 Core Drilling-Conventional								35 2.6 Fuel Cost (\$/Gal.)			
36 Downhole Motors								36			
37 Deviation Subs & Tools								37 2.7 Transportation and Misc. Cost (\$/Hr.)			
38 Telemetry Systems								38			
39 Other								39 2.8 Rental Cost (\$/Hr.)			
40 Core Drilling-Wireline								40			
41 Downhole Motors								41 2.9 Special Tool Cost (\$/Hr.)			
42 Deviation Subs & Tools								42 Air Compressors & Aux. Equip.			
43 Telemetry Systems								43 Air Hammers			
44 Other								44 Downhole Motors			
45 Other								45 Deviation Subs & Tools			
46 Reaming (Ft.)								46 Telemetry Systems			
47								47 Other - Rotary Drilling - Air			
48 1.5 Rig Selection								48 Other - Rotary Drilling - Mud			
49								49 Other - Downhole Motor - Mud			
50 1.6 Bit Program								50 Other - Core Drilling - Conv.			
51 Rotary Drilling-Air								51 Other - Core Drilling - Wireline			

DATABASE A.								DATABASE B.			
WELL DESIGN AND DRILLING INSTRUCTIONS								OPERATION TIME AND COST DATA			
Requirement	Zone A	Zone B	Zone C	Zone D	Zone E	Zone F	Zone G	Operation	Op Time (Hrs.)	Oper. Cost (\$)	Misc.
52 Bit Selection								52 Other - Other			
53 Bit Cost (\$/Bit)								53			
54 Bit Life (Avg. Hrs.)								54 2.10 Supervision Cost (\$/Hr.)			
55 Rotary Drilling-Mud								55			
56 Bit Selection								56 2.11 Condition Drilling Fluids (Avg. Hrs.)			
57 Bit Cost (\$/Bit)								57			
58 Bit Life (Avg. Hrs.)								58 2.12 Water Cost (Total \$)			
59 Downhole Motor - Mud								59 Purchase Cost			
60 Bit Selection								60 Disposal Cost			
61 Bit Cost (\$/Bit)								61			
62 Bit Life (Avg. Hrs.)								62 2.13 Bit Change (Avg. Hrs.)			
63 Core Drilling - Conventional								63			
64 Bit Selection								64 2.14 Bottomhole Assembly (BHA) Change (Avg. Hrs.)			
65 Bit Cost (\$/Bit)								65			
66 Bit Life (Avg. Hrs.)								66			
67 Core Drilling - Wireline								67 2.15 Drilling Penetration Rates (Ft./Hr.)			
68 Bit Selection								68 Zone A			
69 Bit Cost (\$/Bit)								69 Rotary Drlg.-Air			
70 Bit Life (Avg. Hrs.)								70 Rotary Drlg.-Mud			
71 Other								71 Downhole Mtr. Drlg.			
72 Cutter Selection								72 Core Drilling - Conventional			
73 Cost (\$)								73 Core Drilling - Wireline			
74 Cutter Life (Avg. Hrs.)								74 Other			
75								75 Zone B			
76 1.7 Drilling Fluids Program								76 Rotary Drlg.-Air			
77 Surface System Build Up								77 Rotary Drlg.-Mud			
78 Surface Sys. Vol. (BBLS.)								78 Downhole Mtr. Drlg.			
79 Additives (Types)								79 Core Drilling - Conventional			
80 Total Unit Cost (\$/100 BBLS.)								80 Core Drilling - Wireline			
81 Additional Volume								81 Other			
82 Additives (Types)								82 Zone C			
83 Total Add. Cost (\$/100 BBLS.)								83 Rotary Drlg.-Air			
84 Daily Maintenance								84 Rotary Drlg.-Mud			
85 Cost (\$/Day)								85 Downhole Mtr. Drlg.			
86 Other								86 Core Drilling - Conventional			
87 Equipment Cost (\$)								87 Core Drilling - Wireline			
88 Additives (Types)								88 Other			
89 Unit Cost (\$/Cu.Ft. of Hole)								89 Zone D			
90								90 Rotary Drlg.-Air			
91 1.8 Cement Program								91 Rotary Drlg.-Mud			
92 Cement Type								92 Downhole Mtr. Drlg.			
93 Annulus Fill Ht. (Ft.)								93 Core Drilling - Conventional			
94 Unit Cost (\$/Cu. Ft.)								94 Core Drilling - Wireline			
95								95 Other			

DATABASE A.								DATABASE B.			
WELL DESIGN AND DRILLING INSTRUCTIONS								OPERATION TIME AND COST DATA			
Requirement	Zone A	Zone B	Zone C	Zone D	Zone E	Zone F	Zone G	Operation	Op Time (Hrs.)	Oper. Cost (\$)	Misc.
96								96 Zone E			
97								97 Rotary Drig.-Air			
98 1.9 Auxiliary Operations								98 Rotary Drig.-Mud			
99 Surveying (No. of Runs)								99 Downhole Mtr. Drig.			
100 Logging (No. of Runs)								100 Core Drilling - Conventional			
101 Other (No. of runs)								101 Core Drilling - Wireline			
102								102 Other			
103 1.10 Bottomhole Assembly (BHA) Changes								103 Zone F			
								104 Rotary Drig.-Air			
								105 Rotary Drig.-Mud			
								106 Downhole Mtr. Drig.			
								107 Core Drilling - Conventional			
								108 Core Drilling - Wireline			
								109 Other			
								110 Zone G			
								111 Rotary Drig.-Air			
								112 Rotary Drig.-Mud			
								113 Downhole Mtr. Drig.			
								114 Core Drilling - Conventional			
								115 Core Drilling - Wireline			
								116 Other			
								117			
								118 2.16 Reaming Operations			
								119 Reaming Rates (Ft./Hr.)			
								120 Zone A			
								121 Zone B			
								122 Zone C			
								123 Zone D			
								124 Zone E			
								125 Zone F			
								126 Zone G			
								127			
								128 2.17 Pipe Handling Operations			
								129 Round Trip (Avg. Hrs./Round Trip)			
								130 0-4999'			
								131 5000-9999'			
								132 10000-14999'			
								133 15000-19999'			
								134 20000-24999'			
								135 25000-29999'			
								136 30000-34999'			
								137 35000-39999'			
								138 40000-44999'			
								139 45000-50000'			

DATABASE A.								DATABASE B.			
WELL DESIGN AND DRILLING INSTRUCTIONS								OPERATION TIME AND COST DATA			
Requirement	Zone A	Zone B	Zone C	Zone D	Zone E	Zone F	Zone G	Operation	Op Time (Hrs.)	Oper. Cost (\$)	Misc.
								Zone F			
								Casing Run Time (Avg.Hrs./1000')			
								Tools & Services (Total Cost \$)			
								Other (Avg. Hrs. & Total Cost \$)			
								Zone G			
								Casing Run Time (Avg.Hrs./1000')			
								Tools & Services (Total Cost \$)			
								Other (Avg. Hrs. & Total Cost \$)			
								2.23 Cementing Operations			
								Rig Up (Avg. Hrs.)			
								Rig Down (Avg. Hrs.)			
								W.D.C./Test (Avg. Hrs.)			
								Other (Avg. Hrs. & Total Cost \$)			
								Zone A			
								Cementing Time (Avg. Hrs.)			
								Tools & Services (Total Cost \$)			
								Other (Avg. Hrs. & Total Cost \$)			
								Zone B			
								Cementing Time (Avg. Hrs.)			
								Tools & Services (Total Cost \$)			
								Other (Avg. Hrs. & Total Cost \$)			
								Zone C			
								Cementing Time (Avg. Hrs.)			
								Tools & Services (Total Cost \$)			
								Other (Avg. Hrs. & Total Cost \$)			
								Zone D			
								Cementing Time (Avg. Hrs.)			
								Tools & Services (Total Cost \$)			
								Other (Avg. Hrs. & Total Cost \$)			
								Zone E			
								Cementing Time (Avg. Hrs.)			
								Tools & Services (Total Cost \$)			
								Other (Avg. Hrs. & Total Cost \$)			
								Zone F			
								Cementing Time (Avg. Hrs.)			
								Tools & Services (Total Cost \$)			
								Other (Avg. Hrs. & Total Cost \$)			
								Zone G			
								Cementing Time (Avg. Hrs.)			
								Tools & Services (Total Cost \$)			
								Other (Avg. Hrs. & Total Cost \$)			

DATABASE A.								DATABASE B.			
WELL DESIGN AND DRILLING INSTRUCTIONS								OPERATION TIME AND COST DATA			
Requirement	Zone A	Zone B	Zone C	Zone D	Zone E	Zone F	Zone G	Operation	Op Time (Hrs.)	Oper. Cost (\$)	Misc.
								:272 2.24 Wellhead Equipment and Installation			
								:273 Install Time & Equip. Cost (Tot. Hrs. & \$):			
								:274 Zone A			
								:275 Zone B			
								:276 Zone C			
								:277 Zone D			
								:278 Zone E			
								:279 Zone F			
								:280 Zone G			
								:281			
								:282			
								:283 2.25 Maintenance and Drilling Problems			
								:284 Percent Zone Time (%)			
								:285 Zone A			
								:286 Maintenance			
								:287 Drilling Problem			
								:288 Zone B			
								:289 Maintenance			
								:290 Drilling Problem			
								:291 Zone C			
								:292 Maintenance			
								:293 Drilling Problem			
								:294 Zone D			
								:295 Maintenance			
								:296 Drilling Problem			
								:297 Zone E			
								:298 Maintenance			
								:299 Drilling Problem			
								:300 Zone F			
								:301 Maintenance			
								:302 Drilling Problem			
								:303 Zone G			
								:304 Maintenance			
								:305 Drilling Problem			
								:306			

CALCULATION AREA 1.		OPERATION VARIABLE COST CALCULATION (Day Rate)						
Operation	Rig Operating Rate (\$/Hr.)	Fuel Cost (\$/Hr.)	Trans. & Misc. Cost (\$/Hr.)	Rental Cost (\$/Hr.)	Special Tools & Cost (\$/Hr.)	Super. Cost (\$/Hr.)	Oper. Var. Cost (\$/Hr.)	
51								
52 Zone E								
53 Drilling Operations								
54 Rotary Drilling - Air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
55 Rotary Drilling - Mud	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
56 Downhole Motor - Mud	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
57 Core Drig. - Conventional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
58 Core Drig. - Wireline	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
59 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
60 Reaming	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
61 Standby/Non Drig. Oper.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
62								
63 Zone F								
64 Drilling Operations								
65 Rotary Drilling - Air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
66 Rotary Drilling - Mud	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
67 Downhole Motor - Mud	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
68 Core Drig. - Conventional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
69 Core Drig. - Wireline	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
70 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
71 Reaming	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
72 Standby/Non Drig. Oper.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
73								
74 Zone G								
75 Drilling Operations								
76 Rotary Drilling - Air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
77 Rotary Drilling - Mud	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
78 Downhole Motor - Mud	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
79 Core Drig. - Conventional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
80 Core Drig. - Wireline	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
81 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
82 Reaming	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
83 Standby/Non Drig. Oper.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
84								
85 Tripping								
86 0-4999'		0.00						
87 5000-9999'		0.00						
88 10000-14999'		0.00						
89 15000-19999'		0.00						
90 20000-24999'		0.00						
91 25000-29999'		0.00						
92 30000-34999'		0.00						
93 35000-39999'		0.00						

CALCULATION AREA 1.		OPERATION VARIABLE COST CALCULATION (Day Rate)						
Operation		Rig Operating Rate (\$/Hr.)	Fuel Cost (\$/Hr.)	Trans. & Misc. Cost (\$/Hr.)	Rental Cost (\$/Hr.)	Special Tools & Cost (\$/Hr.)	Super. Cost (\$/Hr.)	Oper. Var. Cost (\$/Hr.)
94 40000-44999'			0.00					
95 45000-50000'			0.00					

TIME AND COST ANALYSIS										
(Day Rate)										
Operation	Zone	No. of Oper. Req. (\$)	Depth (Ft.)	Depth Drilled (Ft.)	Total Oper. Time (Hrs.)	Total Oper. Fixed Cost (\$)	Total Oper. Var Cost (\$)	Cum. Time (Hrs.)	Cum. Cost (\$)	
8 Road Location & Site Prep.	--	1	0	0	0	0.00	0.00	0	0.00	
9 Initiation	--	1	0	0	0	0.00	0.00	0	0.00	
10 Mobilization	--	1	0	0	0	0.00	0.00	0	0.00	
11 Water Purchase	--	1	0	0	0	0.00	0.00	0	0.00	
12										
13 Drilling Operations	A	-----	0	0	-----	-----	-----	-----	-----	
14 Rotary - Air	A	-----	-----	0	0	0.00	0.00	0	0.00	
15 Rotary - Mud	A	-----	-----	0	0	0.00	0.00	0	0.00	
16 Downhole Motor - Mud	A	-----	-----	0	0	0.00	0.00	0	0.00	
17 Core Drilling - Conventional	A	-----	-----	0	0	0.00	0.00	0	0.00	
18 Core Drilling - Wireline	A	-----	-----	0	0	0.00	0.00	0	0.00	
19 Other	A	-----	-----	0	0	0.00	0.00	0	0.00	
20 Reaming	A	-----	-----	0	0	0.00	0.00	0	0.00	
21 Bits/Cutters	A	-----	0	-----	0	0.00	0.00	0	0.00	
22 BHA	A	-----	0	-----	0	0.00	0.00	0	0.00	
23 Tripping Operations	A	-----	0	-----	0	0.00	0.00	0	0.00	
24 Auxiliary Operations	A	-----	-----	-----	-----	-----	-----	-----	-----	
25 Surveying	A	-----	0	-----	0	0.00	0.00	0	0.00	
26 Logging	A	-----	0	-----	0	0.00	0.00	0	0.00	
27 Other	A	-----	0	-----	0	0.00	0.00	0	0.00	
28 Drilling Fluids	A	-----	-----	-----	-----	-----	-----	-----	-----	
29 Surface Sys. Build Up	A	-----	0	0	0	0.00	0.00	0	0.00	
30 Additive Volume	A	-----	-----	-----	0	0.00	0.00	0	0.00	
31 Daily Maintenance	A	-----	-----	-----	0	0.00	0.00	0	0.00	
32 Other	A	-----	-----	-----	0	0.00	0.00	0	0.00	
33 Casing Operations	A	-----	0	0	-----	-----	-----	-----	-----	
34 Condition Drig. Fluids	A	-----	-----	-----	0	-----	0.00	0	0.00	
35 Rig Up Casing Tools	A	-----	-----	-----	0	-----	0.00	0	0.00	
36 Prepare to Run Casing	A	-----	-----	-----	0	-----	0.00	0	0.00	
37 Other	A	-----	-----	-----	0	0.00	0.00	0	0.00	
38 Run Casing	A	-----	-----	-----	-----	-----	-----	-----	-----	
39 Casing	A	-----	-----	-----	0	0.00	0.00	0	0.00	
40 Tools & Services	A	-----	-----	-----	-----	0.00	0.00	0	0.00	
41 Other	A	-----	-----	-----	0	0.00	0.00	0	0.00	
42 Rig Down Casing Tools	A	-----	-----	-----	0	-----	0.00	0	0.00	
43 Cementing Operations	A	-----	0	0	-----	-----	-----	-----	-----	
44 Condition Drig. Fluids	A	-----	-----	-----	0	-----	0.00	0	0.00	
45 Rig Up Cement Tools	A	-----	-----	-----	0	-----	0.00	0	0.00	
46 Other	A	-----	-----	-----	0	0.00	0.00	0	0.00	
47 Cementing	A	-----	-----	-----	-----	-----	-----	-----	-----	
48 Cement	A	-----	-----	-----	0	0.00	0.00	0	0.00	
49 Tools & Services	A	-----	-----	-----	-----	0.00	0.00	0	0.00	
50 Other	A	-----	-----	-----	0	0.00	0.00	0	0.00	

CALCULATION AREA 2.			TIME AND COST ANALYSIS (Day Rate)							
Operation	Zone	No. of Oper. Req. (#)	Depth (Ft.)	Depth Drilled (Ft.)	Total Oper. Time (Hrs.)	Total Oper. Fixed Cost (\$)	Total Oper. Var Cost (\$)	Cum. Time (Hrs.)	Cum. Cost (\$)	
51 Install Wellhead	A	-----	-----	-----	0	0.00	0.00	0	0.00	
52 WOC/Test	A	-----	-----	-----	0	-----	0.00	0	0.00	
53 Rig Down Cement Tools	A	-----	-----	-----	0	-----	0.00	0	0.00	
54										
55 Drilling Operations	B	-----	0	0	-----	-----	-----	-----	-----	
56 Rotary - Air	B	-----	-----	0	0	0.00	0.00	0	0.00	
57 Rotary - Mud	B	-----	-----	0	0	0.00	0.00	0	0.00	
58 Downhole Motor - Mud	B	-----	-----	0	0	0.00	0.00	0	0.00	
59 Core Drilling - Conventional	B	-----	-----	0	0	0.00	0.00	0	0.00	
60 Core Drilling - Wireline	B	-----	-----	0	0	0.00	0.00	0	0.00	
61 Other	B	-----	-----	0	0	0.00	0.00	0	0.00	
62 Reaming	B	-----	-----	0	0	0.00	0.00	0	0.00	
63 Bits/Cutters	B	0	-----	-----	0	0.00	0.00	0	0.00	
64 BHA	B	0	-----	-----	0	0.00	0.00	0	0.00	
65 Tripping Operations	B	0	-----	-----	0	0.00	0.00	0	0.00	
66 Auxiliary Operations	B	-----	-----	-----	-----	-----	-----	-----	-----	
67 Surveying	B	0	-----	-----	0	0.00	0.00	0	0.00	
68 Logging	B	0	-----	-----	0	0.00	0.00	0	0.00	
69 Other	B	0	-----	-----	0	0.00	0.00	0	0.00	
70 Drilling Fluids	B	-----	-----	-----	-----	-----	-----	-----	-----	
71 Surface Sys. Build Up	B	-----	-----	-----	0	0.00	0.00	0	0.00	
72 Additive Volume	B	-----	-----	-----	0	0.00	0.00	0	0.00	
73 Daily Maintenance	B	-----	-----	-----	0	0.00	0.00	0	0.00	
74 Other	B	-----	-----	-----	0	0.00	0.00	0	0.00	
75 Casing Operations	B	0	0	-----	-----	-----	-----	-----	-----	
76 Condition Drig. Fluids	B	-----	-----	-----	0	-----	0.00	0	0.00	
77 Rig up Casing Tools	B	-----	-----	-----	0	-----	0.00	0	0.00	
78 Prepare to Run Casing	B	-----	-----	-----	0	-----	0.00	0	0.00	
79 Other	B	-----	-----	-----	0	0.00	0.00	0	0.00	
80 Run Casing	B	-----	-----	-----	-----	-----	-----	-----	-----	
81 Casing	B	-----	-----	-----	0	0.00	0.00	0	0.00	
82 Tools & Services	B	-----	-----	-----	-----	0.00	0.00	0	0.00	
83 Other	B	-----	-----	-----	0	0.00	0.00	0	0.00	
84 Rig Down Casing Tools	B	-----	-----	-----	0	-----	0.00	0	0.00	
85 Cementing Operations	B	0	0	-----	-----	-----	-----	-----	-----	
86 Condition Drig. Fluids	B	-----	-----	-----	0	-----	0.00	0	0.00	
87 Rig Up Cement Tools	B	-----	-----	-----	0	-----	0.00	0	0.00	
88 Other	B	-----	-----	-----	0	0.00	0.00	0	0.00	
89 Cementing	B	-----	-----	-----	-----	-----	-----	-----	-----	
90 Cement	B	-----	-----	-----	0	0.00	0.00	0	0.00	
91 Tools & Services	B	-----	-----	-----	-----	0.00	0.00	0	0.00	
92 Other	B	-----	-----	-----	0	0.00	0.00	0	0.00	
93 Install Wellhead	B	-----	-----	-----	0	0.00	0.00	0	0.00	

CALCULATION AREA 2.			TIME AND COST ANALYSIS (Day Rate)							
Operation	Zone	No. of Oper. Req.	Depth	Depth Drilled	Total Oper. Time	Total Oper. Fixed Cost	Total Oper. Var Cost	Cum. Time	Cum. Cost	
		(#)	(Ft.)	(Ft.)	(Hrs.)	(\$)	(\$)	(Hrs.)	(\$)	
94 WOC/Test	B	-----	-----	-----	0	-----	0.00	0	0.00	
95 Rig Down Cement Tools	B	-----	-----	-----	0	-----	0.00	0	0.00	
96		-----	-----	-----	-----	-----	-----	-----	-----	
97 Drilling Operations	C	-----	0	0	-----	-----	-----	-----	-----	
98 Rotary - Air	C	-----	-----	0	0	0.00	0.00	0	0.00	
99 Rotary - Mud	C	-----	-----	0	0	0.00	0.00	0	0.00	
100 Downhole Motor - Mud	C	-----	-----	0	0	0.00	0.00	0	0.00	
101 Core Drilling - Conventional	C	-----	-----	0	0	0.00	0.00	0	0.00	
102 Core Drilling - Wireline	C	-----	-----	0	0	0.00	0.00	0	0.00	
103 Other	C	-----	-----	0	0	0.00	0.00	0	0.00	
104 Reaming	C	-----	-----	0	0	0.00	0.00	0	0.00	
105 Bits/Cutters	C	0	-----	-----	0	0.00	0.00	0	0.00	
106 BHA	C	0	-----	-----	0	0.00	0.00	0	0.00	
107 Tripping Operations	C	0	-----	-----	0	0.00	0.00	0	0.00	
108 Auxiliary Operations	C	-----	-----	-----	-----	-----	-----	-----	-----	
109 Surveying	C	0	-----	-----	0	0.00	0.00	0	0.00	
110 Logging	C	0	-----	-----	0	0.00	0.00	0	0.00	
111 Other	C	0	-----	-----	0	0.00	0.00	0	0.00	
112 Drilling Fluids	C	-----	-----	-----	-----	-----	-----	-----	-----	
113 Surface Sys. Build Up	C	-----	-----	-----	0	0.00	0.00	0	0.00	
114 Additive Volume	C	-----	-----	-----	0	0.00	0.00	0	0.00	
115 Daily Maintenance	C	-----	-----	-----	0	0.00	0.00	0	0.00	
116 Other	C	-----	-----	-----	0	0.00	0.00	0	0.00	
117 Casing Operations	C	0	0	-----	-----	-----	-----	-----	-----	
118 Condition Drig. Fluids	C	-----	-----	-----	0	-----	0.00	0	0.00	
119 Rig Up Casing Tools	C	-----	-----	-----	0	-----	0.00	0	0.00	
120 Prepare to Run Casing	C	-----	-----	-----	0	-----	0.00	0	0.00	
121 Other	C	-----	-----	-----	0	0.00	0.00	0	0.00	
122 Run Casing	C	-----	-----	-----	-----	-----	-----	-----	-----	
123 Casing	C	-----	-----	-----	0	0.00	0.00	0	0.00	
124 Tools & Services	C	-----	-----	-----	-----	0.00	0.00	0	0.00	
125 Other	C	-----	-----	-----	0	0.00	0.00	0	0.00	
126 Rig Down Casing Tools	C	-----	-----	-----	0	-----	0.00	0	0.00	
127 Cementing Operations	C	0	0	-----	-----	-----	-----	-----	-----	
128 Condition Drig. Fluids	C	-----	-----	-----	0	-----	0.00	0	0.00	
129 Rig Up Cement Tools	C	-----	-----	-----	0	-----	0.00	0	0.00	
130 Other	C	-----	-----	-----	0	0.00	0.00	0	0.00	
131 Cementing	C	-----	-----	-----	-----	-----	-----	-----	-----	
132 Cement	C	-----	-----	-----	0	0.00	0.00	0	0.00	
133 Tools & Services	C	-----	-----	-----	-----	0.00	0.00	0	0.00	
134 Other	C	-----	-----	-----	0	0.00	0.00	0	0.00	
135 Install Wellhead	C	-----	-----	-----	0	0.00	0.00	0	0.00	
136 WOC/Test	C	-----	-----	-----	0	-----	0.00	0	0.00	

CALCULATION AREA 2.			TIME AND COST ANALYSIS (Day Rate)							
Operation	Zone	No. of Oper. Req. (#)	Depth (Ft.)	Depth Drilled (Ft.)	Total Oper. Time (Hrs.)	Total Oper. Fixed Cost (\$)	Total Oper. Var Cost (\$)	Cum. Time (Hrs.)	Cum. Cost (\$)	
1137 Rig Down Cement Tools	C	-----	-----	-----	0	-----	0.00	0	0.00	
1138										
1139 Drilling Operations	D	-----	0	0	-----	-----	-----	-----	-----	
1140 Rotary - Air	D	-----	-----	0	0	0.00	0.00	0	0.00	
1141 Rotary - Mud	D	-----	-----	0	0	0.00	0.00	0	0.00	
1142 Downhole Motor - Mud	D	-----	-----	0	0	0.00	0.00	0	0.00	
1143 Core Drilling - Conventional	D	-----	-----	0	0	0.00	0.00	0	0.00	
1144 Core Drilling - Wireline	D	-----	-----	0	0	0.00	0.00	0	0.00	
1145 Other	D	-----	-----	0	0	0.00	0.00	0	0.00	
1146 Reaming	D	-----	-----	0	0	0.00	0.00	0	0.00	
1147 Bits/Cutters	D	0	-----	-----	0	0.00	0.00	0	0.00	
1148 BHA	D	0	-----	-----	0	0.00	0.00	0	0.00	
1149 Tripping Operations	D	0	-----	-----	0	0.00	0.00	0	0.00	
1150 Auxiliary Operations	D	-----	-----	-----	-----	-----	-----	-----	-----	
1151 Surveying	D	0	-----	-----	0	0.00	0.00	0	0.00	
1152 Logging	D	0	-----	-----	0	0.00	0.00	0	0.00	
1153 Other	D	0	-----	-----	0	0.00	0.00	0	0.00	
1154 Drilling Fluids	D	-----	-----	-----	-----	-----	-----	-----	-----	
1155 Surface Sys. Build Up	D	-----	-----	-----	0	0.00	0.00	0	0.00	
1156 Additive Volume	D	-----	-----	-----	0	0.00	0.00	0	0.00	
1157 Daily Maintenance	D	-----	-----	-----	0	0.00	0.00	0	0.00	
1158 Other	D	-----	-----	-----	0	0.00	0.00	0	0.00	
1159 Casing Operations	D	0	0	-----	-----	-----	-----	-----	-----	
1160 Condition Drlg. Fluids	D	-----	-----	-----	0	-----	0.00	0	0.00	
1161 Rig Up Casing Tools	D	-----	-----	-----	0	-----	0.00	0	0.00	
1162 Prepare to Run Casing	D	-----	-----	-----	0	-----	0.00	0	0.00	
1163 Other	D	-----	-----	-----	0	0.00	0.00	0	0.00	
1164 Run Casing	D	-----	-----	-----	-----	-----	-----	-----	-----	
1165 Casing	D	-----	-----	-----	0	0.00	0.00	0	0.00	
1166 Tools & Services	D	-----	-----	-----	-----	0.00	0.00	0	0.00	
1167 Other	D	-----	-----	-----	0	0.00	0.00	0	0.00	
1168 Rig Down Casing Tools	D	-----	-----	-----	0	-----	0.00	0	0.00	
1169 Cementing Operations	D	0	0	-----	-----	-----	-----	-----	-----	
1170 Condition Drlg. Fluids	D	-----	-----	-----	0	-----	0.00	0	0.00	
1171 Rig Up Cement Tools	D	-----	-----	-----	0	-----	0.00	0	0.00	
1172 Other	D	-----	-----	-----	0	-----	0.00	0	0.00	
1173 Cementing	D	-----	-----	-----	-----	0.00	-----	-----	-----	
1174 Cement	D	-----	-----	-----	0	0.00	0.00	0	0.00	
1175 Tools & Services	D	-----	-----	-----	-----	0.00	0.00	0	0.00	
1176 Other	D	-----	-----	-----	0	0.00	0.00	0	0.00	
1177 Install Wellhead	D	-----	-----	-----	0	0.00	0.00	0	0.00	
1178 WDC/Test	D	-----	-----	-----	0	-----	0.00	0	0.00	
1179 Rig Down Cement Tools	D	-----	-----	-----	0	-----	0.00	0	0.00	

TIME AND COST ANALYSIS
(Day Rate)

[illegible]

CALCULATION AREA 2.			TIME AND COST ANALYSIS (Day Rate)							
Operation	Zone	No. of Oper. Req. (#)	Depth (Ft.)	Depth Drilled (Ft.)	Total Oper. Time (Hrs.)	Total Oper. Fixed Cost (\$)	Total Oper. Var Cost (\$)	Cum. Time (Hrs.)	Cum. Cost (\$)	
1223 Drilling Operations	F	-----	0	0	-----	-----	-----	-----	-----	
1224 Rotary - Air	F	-----	-----	0	0	0.00	0.00	0	0.00	
1225 Rotary - Mud	F	-----	-----	0	0	0.00	0.00	0	0.00	
1226 Downhole Motor - Mud	F	-----	-----	0	0	0.00	0.00	0	0.00	
1227 Core Drilling - Conventional	F	-----	-----	0	0	0.00	0.00	0	0.00	
1228 Core Drilling - Wireline	F	-----	-----	0	0	0.00	0.00	0	0.00	
1229 Other	F	-----	-----	0	0	0.00	0.00	0	0.00	
1230 Reaming	F	-----	-----	0	0	0.00	0.00	0	0.00	
1231 Bits/Cutters	F	0	-----	-----	0	0.00	0.00	0	0.00	
1232 BHA	F	0	-----	-----	0	0.00	0.00	0	0.00	
1233 Tripping Operations	F	0	-----	-----	0	0.00	0.00	0	0.00	
1234 Auxiliary Operations	F	-----	-----	-----	-----	-----	0.00	0	0.00	
1235 Surveying	F	0	-----	-----	0	0.00	0.00	0	0.00	
1236 Logging	F	0	-----	-----	0	0.00	0.00	0	0.00	
1237 Other	F	0	-----	-----	0	0.00	0.00	0	0.00	
1238 Drilling Fluids	F	-----	-----	-----	-----	-----	-----	-----	-----	
1239 Surface Sys. Build Up	F	-----	-----	-----	0	0.00	0.00	0	0.00	
1240 Additive Volume	F	-----	-----	-----	0	0.00	0.00	0	0.00	
1241 Daily Maintenance	F	-----	-----	-----	0	0.00	0.00	0	0.00	
1242 Other	F	-----	-----	-----	0	0.00	0.00	0	0.00	
1243 Casing Operations	F	0	0	-----	-----	-----	-----	-----	-----	
1244 Condition Drig. Fluids	F	-----	-----	-----	0	-----	0.00	0	0.00	
1245 Rig Up Casing Tools	F	-----	-----	-----	0	-----	0.00	0	0.00	
1246 Prepare to Run Casing	F	-----	-----	-----	0	-----	0.00	0	0.00	
1247 Other	F	-----	-----	-----	0	0.00	0.00	0	0.00	
1248 Run Casing	F	-----	-----	-----	-----	-----	-----	-----	-----	
1249 Casing	F	-----	-----	-----	0	0.00	0.00	0	0.00	
1250 Tools & Services	F	-----	-----	-----	-----	0.00	0.00	0	0.00	
1251 Other	F	-----	-----	-----	0	0.00	0.00	0	0.00	
1252 Rig Down Casing Tools	F	-----	-----	-----	0	-----	0.00	0	0.00	
1253 Cementing Operations	F	0	0	-----	-----	-----	-----	-----	-----	
1254 Condition Drig. Fluids	F	-----	-----	-----	0	-----	0.00	0	0.00	
1255 Rig Up Cement Tools	F	-----	-----	-----	0	-----	0.00	0	0.00	
1256 Other	F	-----	-----	-----	0	0.00	0.00	0	0.00	
1257 Cementing	F	-----	-----	-----	-----	-----	-----	-----	-----	
1258 Cement	F	-----	-----	-----	0	0.00	0.00	0	0.00	
1259 Tools & Services	F	-----	-----	-----	-----	0.00	0.00	0	0.00	
1260 Other	F	-----	-----	-----	0	0.00	0.00	0	0.00	
1261 Install Wellhead	F	-----	-----	-----	0	0.00	0.00	0	0.00	
1262 WOC/Test	F	-----	-----	-----	0	-----	0.00	0	0.00	
1263 Rig Down Cement Tools	F	-----	-----	-----	0	-----	0.00	0	0.00	
1264		-----	-----	-----	-----	-----	-----	-----	-----	
1265 Drilling Operations	S	-----	0	0	-----	-----	-----	-----	-----	

CALCULATION AREA 3.		TIME AND COST ANALYSIS (Footage Rate)						
Operation	Zone	Depth (Ft.)	Depth Drilled (Ft.)	Total Oper. Time (Hrs.)	Total Cost (\$)	Cum. Time (Hrs.)	Cum. Cost (\$)	
8 Drlg., Casing, Cem., etc.	A	0	0	0.0	0.00	0.0	0.00	
9 Drlg., Casing, Cem., etc.	B	0	0	0.0	0.00	0.0	0.00	
10 Drlg., Casing, Cem., etc.	C	0	0	0.0	0.00	0.0	0.00	
11 Drlg., Casing, Cem., etc.	D	0	0	0.0	0.00	0.0	0.00	
12 Drlg., Casing, Cem., etc.	E	0	0	0.0	0.00	0.0	0.00	
13 Drlg., Casing, Cem., etc.	F	0	0	0.0	0.00	0.0	0.00	
14 Drlg., Casing, Cem., etc.	G	0	0	0.0	0.00	0.0	0.00	
15								
16 Total Time						0.0		
17								
18 Total Cost							\$0.00	
19								

CALCULATION AREA 4.		INDIVIDUAL OPERATION			
		Time and Cost Analysis			
Operation	Oper. Total Time (Hrs.)	Percent Total Time (%)	Oper. Total Cost (\$)	Percent Total Cost (%)	
8 Road and Site Prep.	0	0.00%	0.00	0.00%	
9 Drilling Operations	0	0.00%	0.00	0.00%	
10 Bits/Cutters	0	0.00%	0.00	0.00%	
11 BHA	0	0.00%	0.00	0.00%	
12 Tripping Operations	0	0.00%	0.00	0.00%	
13 Auxiliary Operations	0	0.00%	0.00	0.00%	
14 Drilling Fluids	0	0.00%	0.00	0.00%	
15 Casing Operations	0	0.00%	0.00	0.00%	
16 Cementing Operations	0	0.00%	0.00	0.00%	
17 Maintenance	0	0.00%	0.00	0.00%	
18 Drilling Problems	0	0.00%	0.00	0.00%	
19 Other	0	0.00%	0.00	0.00%	
20					
21 Total Program	0	0.00%	\$0.00	0.00%	
22					