Geothermal Loan Guaranty Cash Flow Model—Description and Users' Manual

Mark A. Keimig
Joseph I. Rosenberg
Daniel J. Entingh

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The MITRE Corporation
Metrek Division
1820 Dolley Madison Boulevard
McLean, Virginia 22102

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ABSTRACT

This paper is the users guide for the Geothermal Loan Guaranty Cash Flow Model (GCFM). GCFM is a Fortran code which designs and costs geothermal fields and electric power plants. It contains a financial analysis module which performs life cycle costing analysis taking into account various types of taxes, costs and financial structures. The financial module includes a discounted cash flow feature which calculates a levelized breakeven price for each run. The user's guide contains descriptions of the data requirements and instructions for using the model.

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1.0 INTRODUCTION

1.1 General Background

The MITRE Corporation was requested by the Department of Energy in December 1978 to develop a discounted cash flow analysis model that could assist in the analysis of Geothermal Loan Guaranty applications. This model has been developed and installed at the Department of Energy, San Francisco Operations Office, Geothermal Loan Guaranty Program Office. This manual describes how the model is used.

The objectives of the federal GLGP are essentially threefold:

- (a) To encourage and assist the private and public sectors to accelerate development of geothermal resources with environmentally acceptable processes by enabling the Secretary in the exercise of reasonable judgment to minimize a lender's financial risk that is associated with the development of new geothermal reservoirs and with the application of new technology;
- (b) To develop normal borrower-lender relationships which will in time encourage the flow of credit for geothermal energy projects without the need for Federal assistance;
- (c) To enhance competition and encourage new entrants into the geothermal market.

The purpose of the Geothermal Loan Guaranty Cash Flow Model (GCFM) is to estimate project costs and cash flows for geothermal producer field projects and geothermal electric plant projects during construction and operation.

The model can be operated starting from only a few preliminary estimates of specific geothermal resource characteristics and power plant features. As the knowledge of the reservoir characteristics and plant design improve with time, the more detailed information can be

entered into the model to improve the accuracy of the cash flow projections.

GCFM estimates field and electric plant costs, cash flow patterns, and levelized breakeven prices for either geothermal fluid or electricity. GCFM does not contain provisions for estimating the costs of geothermal direct heat utilization projects.

The model can be run on an IBM 370 VMS system (as developed at the MITRE Corporation), or on a Hewlett-Packard 3000 Series 3 (as installed at the DOE San Francisco Operations Office). The FORTRAN source code for these two computers is slightly different. GCFM requires 750K of memory.

1.2 Organization of this Manual

This manual provides general information about GCFM and instructions for using GCFM once it is installed on a suitable computer system. The manual does not (a) document the source code or (b) suggest appropriate values for either engineering assumptions or financial analysis variables.

Section 2.0 describes the general features and some of the special features of the model.

Section 3.0 describes how data are entered into the model and provides explanations of the significance of each of the input variables.

Section 4.0 presents a variety of interactive terminal sessions and provides working examples on how the GCFM modules are used in sequence to perform desired analyses.

Section 5.0 describes the output from the model.

Appendix A explains the equations used for financial calculations.

Appendix B describes the power plant cycle design and costing routines. Appendix C contains some technical notes that may be of use to advanced users of GCFM.

The reader is urged to read Sections 2.0 through 5.0 of this manual before attempting to use GCFM for the first time. Sections 3.0 and 4.0 are especially important, since 3.0 explains the data entry requirements in general terms, while 4.0 provides many specific examples and directions for data entry.

2.0 MODEL CAPABILITIES

2.1 Description of Model Features

The Geothermal Loan Guaranty Cash Flow Model (GCFM) is designed to evaluate both geothermal power plants and production fields by performing cost and cash flow computations. It estimates both the year-by-year cash flow for a project and a levelized busbar cost of electricity or a levelized price for geothermal fluid.

The model consists of three major sets of programs, namely the (1) Power Plant, (2) Field, and (3) Financial Modules.

Figure 2-1 shows the structural linkages in GCFM. There are two major entities involved in geothermal development, namely field and power plant. They operate in significantly different financial environments, and GCFM is designed to process each of them independently against a generic set of financial parameters.

The Power Plant and Field Modules are cost-estimation routines that perform similar functions. They each utilize information such as the resource characteristics, engineering design and operation criteria, and required expenditure schedules. This information is converted into a series of investments and operating costs on which the financial module performs calculations. Provisions are made inside the costing routines to supply many default values where critical values are not provided by the user.

In some cases default values are calculated based on variable resource conditions. The method by which this is done varies between the Power Plant and Field Modules. The Power Plant Module contains an auxiliary program called the Power Plant Cycle Design Routine.

**FIGURE 2-1
STRUCTURE-MAIN MODULES**

This routine estimates the required nameplate rating for the turbine, calculates the reservoir flow requirements and then calculates the capital cost of the plant and replacement components in 1979 dollars. The cycle design routine will handle four different generic power plant designs: Dry Steam, Single Stage Flash, Dual Stage Flash, and Isobutane Brine/Binary. The power plant equipment costs are based on the GEOCST estimation equations used by Battelle, Pacific Northwest Laboratories, (Battelle, 1977).

In contrast, the Field Module contains no specific "design" program. Model default values for costs, well flows, and other parameters are calculated directly from the resource characteristics. The general method is similar to that of the MITRE Model GELCOM. (MITRE, 1978). The GELCOM field equipment cost equations have been updated to reflect 1979 costs. The costs of wells are based on data supplied by K. Bromberg of DOE San Francisco, expressed in 1979 dollars.

The Financial Module performs life cycle costing on the series of capital expenditures and operating costs created by either the power plant module or the field module. Financial parameters such as the cost of borrowed money, required return on equity, escalation rates, and taxes are combined to estimate the levelized price of electricity necessary to meet the above set of revenue requirements.

Because of the distinction between the power plant and field modules, GCFM can be utilized for analyzing a loan guaranty proposal

submitted by either of the two participants in geothermal development. It is possible that the Geothermal Loan Guaranty Program may provide guaranties for either or both the power plant and field at a given site.

2.2 Types of Projects Which May Be Analyzed

GCFM projects are always either a power plant or a field. These are considered separately because the relatively greater risk involved with geothermal field development makes that investment likely to be a distinct legal and financial entity from the power plant.

Within the Power Plant Module is a dataset involving the cycle design selection. The Power Plant Cycle Design Routine allows a selection from four types of power plants as shown in Table 2-1.

The only distinction made between field designs is what type of power plant it supplies with geothermal fluid. The plants are divided according to the type of vapor driving the turbine. The current choices are steam or isobutane, depending on whether or not the plant is of binary design.

Every financial case is generic and can be used with any project case to the extent that the time structure of the project and financial case are equal. This is to say that if their base years, power on line years, and project lives are equal any project and financial case may be used together.

TABLE 2-1
TYPES OF POWER PLANTS

TYPE OF PLANT	GEOHERMAL FLUID TEMPERATURE RANGE (°F)	COMMENTS
DRY STEAM	400-600	Saturated or superheated steam
SINGLE FLASHED STEAM	350-550	Saturated brine - Flash tank conditions can be defaulted.
DOUBLE FLASHED STEAM	350-550	Saturated brine - Flash tank conditions can be defaulted.
BRINE/BINARY	275-500	Saturated brine - Superheated Isobutane

2.3 Overall Model Structure

The GLGP Cash Flow Model was written in a manner intended to give a user a great deal of flexibility at execution time. The model is structured to allow power plant designs and field designs to be run against a relatively generic set of financial cases. The model includes storage capacity for 10 power plant designs, 10 field designs and 15 financial cases. This gives added flexibility in that multiple projects may be analyzed against a set of financial cases representing different economic conditions.

Generally, a user will begin with the power plant design module because the field design requires the total brine flow needed by the power plant, which is generated by the power plant cycle design routine. However, if this parameter is known it is just as easy to begin with the field design module.

The Financial Module must have a database initialized before it may be run. This is accomplished by executing either the Power Plant Module or the Field Module. The Financial Module will use the cost data from whichever plant or field case was run immediately prior to entering the Financial Module. The financial module may be entered without initialization for the purposes of data entry but no financial analysis may be performed. The execution of a financial analysis without first executing either of the design modules will cause the model to terminate in an error condition. If this accidentally occurs no damage will occur to the permanent databases.

It is possible to enter and execute each routine any number of times without terminating execution of the model.

The financial routine may be entered from either of the two design modules. Upon termination of the financial routine, the program will return to the design module from which it was entered.

The following four Figures show the overall interactive flow of the Power Plant/Module (includes Cycle Design Routine), Field Module and Financial Module. The following rules must be used in conjunction with these Figures (2-2, 2-3, 2-4, and 2-5).

- (1) Entry - This label shows where the flow of the model enters the module.
- (2) All titles in boxes do not represent any input or output to the terminal. They show where certain processes are occurring.
- (3) The flow of calculations follows the path of arrows.

2.4 Special Features of the Model

2.4.1 Time Variant Input

Among the special features of GCFM is the user's ability to vary many input values over time. This allows the user flexibility to simulate conditions which change over time. The escalation factors, tax rates, and other variables have this feature.

2.4.2 Asset Lives

Like many other discounted cash flow models, the capital recovery lifetimes can be assumed to be different from the tax depreciation lifetimes. The tax depreciation schedule uses the sum

* See Individual Flowcharts

FIGURE 2-2
GEOHERMAL CASH FLOW MODEL

**FIGURE 2-3
LOGIC FLOW OF POWER PLANT MODULE**

FIGURE 2-4
LOGIC FLOW OF FIELD MODULE

**FIGURE 2-5
LOGIC FLOW OF FINANCIAL MODULE**

of the years digits method. Capital recovery or book depreciation is calculated on a straight line basis.

2.4.3 Escalation

This model allows the user to separately escalate the price of fuel and electricity, the capital investments on replacements, overhead and maintenance (O&M), costs, and other costs with the passage of time. (Overhead and maintenance costs include all operating expenses relating to the project itself, except for royalties.)

2.4.4 Default Values

One of the most important features of the model is the provision of "default" values for most of the important variables/parameters used in project design and/or costing. The estimates of the default values were derived from the most appropriate empirical or reference data available in the literature concerning geothermal electric projects.

This feature allows the user to obtain an initial set of cash flows and levelized busbar cost estimate with very limited input data. Once the user acquires better data, the default values can be overridden.

2.4.5 Sensitivity Analysis

The interactive mode of operation facilitates the use of this model for checking the sensitivity of cash flow patterns and the cost of power to changes in various parameters. This can be useful in analyzing various ways to enhance the viability of a project.

2.4.6 Modes of Calculation

The Financial Module generates two sets of reports, each representing a different type of calculation. The major difference between them is in the method in which the revenue stream is calculated. The first uses the annual escalated market price to generate the revenue stream from which the profitability of a given project may be calculated. Thus for the market price report, GCFM begins with an assumed series of selling prices, and from the resulting cash flows (between after tax revenues and costs), assesses the ability of a given project to meet its financial obligations on a year-to-year basis.

The second calculation more closely resembles the typical revenue requirements approach used in utility financing. This method calculates a required revenue stream necessary to achieve a desired return on equity. This is called the annual breakeven price. Since this annual price differs from year to year, it is difficult to compare the relative merits of different projects. Through the process of levelization, used throughout the electric utility industry, the required selling price for a given project can be expressed as a single number. Such a number may be considered as the average cost of power, including required return to all parties, over the lifetime of the project. However, there are different ways of levelizing a cash flow stream, depending upon whether the required selling price is to be expressed in current or constant dollars. The GCFM calculates two such levelized prices for use at the user's discretion. Appendix A provides a detailed description of the various modes of calculation employed by the model.

2.4.7 Variable Allocation of Investments

No two projects develop at the same pace. The portion of the plant which is built during any given year depends on situation-specific factors. The model incorporates a feature which allows a variable investment structure. The contrast is most obvious in the case on field versus power plant projects. Many field development expenses will occur long before the power plant construction even begins.

Both the power plant and the field modules have an input variable which consists of a series of fractions which determine the investment schedule throughout the construction period. For example, suppose over a five year period both a power plant and a field are being built at a given site. The investment/construction at the power plant need not begin until after some of the wells have been proven. Table 2-2 is illustrative of how this can be treated.

2.4.8 Debt/Equity Structure During Construction

The model allows a great deal of flexibility in the allocation of expenses between debt and equity during the construction period. The debt/equity ratio is very important because often loan agreements require a minimum level of equity* participation. It is

*The minimum desired level as determined under the rules of the DOE Geothermal Loan Guarantee Program is 25 percent equity participation (or 10 percent for municipal or cooperative borrowers).

TABLE 2-2

HYPOTHETICAL SCHEDULES OF TWO
\$50 MILLION INVESTMENTS

Year	FIELD		POWER PLANT	
	Investment (\$10 ⁶ /Yr)	Fraction of Total	Investment (\$10 ⁶ /Yr)	Fraction of Total
1	10	.2	0	.0
2	20	.4	0	.0
3	10	.2	5	.1
4	5	.1	15	.3
5	5	.1	30	.6

important to achieve this minimum level as closely as possible in order for the borrower to be as highly leveraged as possible. To achieve this degree of leverage, the model has a built-in preference for debt and borrows as much as possible during each construction year.

There are two variables which influence the amount of equity participation in a project. The most critical value is the minimum equity fraction. This variable is treated by the model as a target to be reached by the end of the construction period. The annual equity fraction, the second most important equity variable, determines the minimum fraction, the second important equity variable determines the minimum fraction of the current year's investment which must be capitalized. However, if because of the minimum equity fraction, a larger equity investment is required, this larger investment will be made.

To illustrate this, several cases have been run using the following basic assumptions:

Sunk Costs = 3 Million,
Investment, Year 1 = 6 Million
Investment, Year 2 = 3 Million
Investment, Year 3 = 2 Million
Annual Interest Rate = 10%
DOE User Fee Rate = 1%

These parameters remain constant throughout all of the sample runs. The only parameters which are varied are the Minimum Equity Fraction and the Annual Equity Fraction.

Figure 2-6 is the construction period output of a run using a minimum equity fraction of 0.0 and an annual equity fraction of 0.0. This run exhibits the model's preference for debt.

The only equity in this project is the 3 million dollars in sunk costs.* The annual investment, the interest and the DOE fees are all borrowed. Notice the equity fraction declines in each year and reaches 0.174 in year three.

Figure 2-7 shows what happens when the minimum equity fraction is changed to 0.25. Notice the first year the entire 8.5 million investment is borrowed and it is not until the second and third years that equity investments must be made to maintain the equity fraction at 0.25.

Figure 2-8 represents a run using a minimum equity fraction of 0.25 and annual equity fractions of 0.10. The values of the latter cause the debt preference of the model to be altered. The model will now require equity participation of at least 10% of each annual investment. This is useful when a developer has been given credit for a large amount of sunk costs, because it will prevent the model from assuming the use of 100% debt to cover early year investments.

*Sunk costs represent fixed investment by the borrower prior to application for guaranteed loan.

**GLGP CASH FLOW MODEL
CONSTRUCTION PERIOD #F1.1**

**PROJECT NAME - TEST/V3.0
PROJECT TYPE - FIELD**

**FINANCIAL CASE NAME - DEMO
FINANCIAL STRUCTURE - TAXABLE ENTITY**

YEAR	CONSTRUCTION COST	ANNUAL INTEREST	ANNUAL DOE FEE	ANNUAL DEBT	ANNUAL EQUITY	CUMULATIVE DEBT	CUMULATIVE EQUITY	EQUITY FRACTION
SUNK COSTS	3000.0	0.0	0.0	0.0	3000.0	0.0	3000.0	1.000
1 - 1980	8511.6	912.2	47.4	9471.1	0.0	9471.1	3000.0	0.241
2 - 1981	4255.8	1471.1	76.4	5803.3	0.0	15274.4	3000.0	0.164
3 - 1982	2837.2	1941.0	100.8	4879.0	0.0	20153.4	3000.0	0.130
TOTAL	18604.6	4324.3	224.5	20153.4	3000.0			

CONSTRUCTION BUDGET (K\$/1980):

SUNK EQUITY COSTS = 3000.0
PROJECT CAPITAL COST = 15604.6
WORKING CAPITAL = 0.0

MINIMUM EQUITY FRACTION = 0.0
DOE FEE = 0.010

TOTAL (LESS FINANCING) = 18604.6

DOE FEE'S AND INTEREST = 4548.8

TOTAL CAPITAL COST = 23153.4

YEAR	INTEREST RATE	INVESTMENT BREAKDOWN	ANNUAL ** TAX LOSSES
1 - 1980	0.100	0.545	959.5
2 - 1981	0.100	0.273	1547.5
3 - 1982	0.100	0.182	2041.8

** - ANNUAL TAX LOSSES INCLUDE CONSTRUCTION PERIOD DRY HOLE EXPENSES, EXPLORATION COSTS, INTANGIBLE DRILLING COSTS, DOE FEES, AND INTEREST.

**FIGURE 2-6
CONSTRUCTION PERIOD OUTPUT WITH NO MINIMUM
OR ANNUAL EQUITY FRACTIONS REQUIRED**

**GLGE CASH FLOW MODEL
CONSTRUCTION PERIOD #P1.1**

**PROJECT NAME - TEST/V3.0
PROJECT TYPE - FIELD**

**FINANCIAL CASE NAME - DEMO
FINANCIAL STRUCTURE - TAXABLE ENTITY**

YEAR	CONSTRUCTION COST	ANNUAL INTEREST	ANNUAL DOE FEE	ANNUAL DEBT	ANNUAL EQUITY	CUMULATIVE DEBT	CUMULATIVE EQUITY	EQUITY FRACTION
SUNK COSTS	3000.0	0.0	0.0	0.0	3000.0	0.0	3000.0	1.000
1 - 1980	8511.6	907.6	46.7	9349.4	116.5	9349.4	3116.5	0.250
2 - 1981	4255.8	1320.5	67.9	4233.2	1411.1	13582.6	4527.5	0.250
3 - 1982	2837.2	1654.2	85.1	3432.4	1144.1	17015.0	5671.7	0.250
TOTAL	18604.6	3882.4	199.7	17015.0	5671.7			

CONSTRUCTION BUDGET (K\$/1980):

SUNK EQUITY COSTS = 3000.0
 PROJECT CAPITAL COST = 15604.6
 WORKING CAPITAL = 0.0
 TOTAL (LESS FINANCING) = 18604.6
 DOE FEE'S AND INTEREST = 4082.1
 TOTAL CAPITAL COST = 22686.7

MINIMUM EQUITY FRACTION = 0.250
 DOE FEE = 0.010

YEAR	INTEREST RATE	INVESTMENT BREAKDOWN	ANNUAL ** TAX LOSSES
1 - 1980	0.100	0.545	954.3
2 - 1981	0.100	0.273	1388.4
3 - 1982	0.100	0.182	1739.3

**** - ANNUAL TAX LOSSES INCLUDE CONSTRUCTION PERIOD DRY HOLE EXPENSES, EXPLORATION COSTS, INTANGIBLE DRILLING COSTS, DOE FEES, AND INTEREST.**

**FIGURE 2-7
CONSTRUCTION PERIOD WITH MINIMUM TOTAL
EQUITY FRACTION OF 0.25**

**GLGP CASH FLOW MODEL
CONSTRUCTION PERIOD #F1.1**

**PROJECT NAME - TEST/V3.0
PROJECT TYPE - FIELD**

**FINANCIAL CASE NAME - DEMO
FINANCIAL STRUCTURE - TAXABLE ENTITY**

YEAR	CONSTRUCTION COST	ANNUAL INTEREST	ANNUAL DOE FEE	ANNUAL DEBT	ANNUAL EQUITY	CUMULATIVE DEBT	CUMULATIVE EQUITY	EQUITY FRACTION
SUNK COSTS	3000.0	0.0	0.0	0.0	3000.0	0.0	3000.0	1.000
1 - 1980	8511.6	821.0	42.6	8524.0	851.2	8524.0	3851.2	0.311
2 - 1981	4255.8	1312.8	67.5	4984.4	651.7	13508.4	4502.8	0.250
3 - 1982	2837.2	1646.4	84.7	3426.2	1142.1	16934.7	5644.9	0.250
TOTAL	18604.6	3780.2	194.8	16934.7	5644.9			

CONSTRUCTION BUDGET (K\$/1980):

SUNK EQUITY COSTS = 3000.0
PROJECT CAPITAL COST = 15604.6
WORKING CAPITAL = 0.0

MINIMUM EQUITY FRACTION = 0.250
DOE FEE = 0.010

TOTAL (LESS FINANCING) = 18604.6

DOE FEE'S AND INTEREST = 3975.0

TOTAL CAPITAL COST = 22579.6

YEAR	INTEREST RATE	INVESTMENT BREAKDOWN	ANNUAL ** TAX LOSSES
1 - 1980	0.100	0.545	863.6
2 - 1981	0.100	0.273	1380.3
3 - 1982	0.100	0.182	1731.1

** - ANNUAL TAX LOSSES INCLUDE CONSTRUCTION PERIOD DRY HOLE EXPENSES, EXPLORATION COSTS, INTANGIBLE DRILLING COSTS, DOE FEES, AND INTEREST.

**FIGURE 2-8
CONSTRUCTION PERIOD WITH MINIMUM TOTAL
EQUITY FRACTION OF 0.25 AND ANNUAL EQUITY
FRACTIONS OF 0.1**

In the run represented by Figure 2-9, the annual equity investments are increased to 0.25. This causes the model to require equity investments to comprise 25% of each annual investment. Because of this requirement, coupled with the 100% equity sunk costs the minimum equity fraction is never approached.

2.4.9 Financial Case Initialization

There is a great deal of data entry involved in the creation of any new financial case. After entering several cases the user may discover that he is entering similar data values for many parameters. For this reason the model contains a feature which allows the user to set up a baseline set of values which may (at the users request) be used to initialize any subsequent financial cases. This allows the user to bypass the financial input routine and proceed to the change routine. In many cases this can save a great deal of time.

The mechanics of this feature are relatively simple. The user first creates a new financial case called "BASELINE" entering only those values which are to make up the initial data. From then on, any time a new financial case is created, the model will ask the user if the new case is to be initialized with the data in the "baseline case." If the user answers yes, the model performs the initialization and enters the change routine, bypassing the financial data entry routine. The user will then alter variables as needed for the new financial case.

**GLGP CASH FLOW MODEL
CONSTRUCTION PERIOD #P1.1**

**PROJECT NAME - TEST/V3.0
PROJECT TYPE - FIELD**

**FINANCIAL CASE NAME - DEMO
FINANCIAL STRUCTURE - TAXABLE ENTITY**

YEAR	CONSTRUCTION COST	ANNUAL INTEREST	ANNUAL DOE FEE	ANNUAL DEBT	ANNUAL EQUITY	CUMULATIVE DEBT	CUMULATIVE EQUITY	EQUITY FRACTION
SUNK COSTS	3000.0	0.0	0.0	0.0	3000.0	0.0	3000.0	1.000
1 - 1980	8511.6	684.1	35.5	7103.3	2127.9	7103.3	5127.9	0.419
2 - 1981	4255.8	1103.3	57.3	4352.5	1064.0	11455.8	6191.8	0.351
3 - 1982	2837.2	1455.8	75.6	3659.2	709.3	15115.0	6901.1	0.313
TOTAL	18604.6	3243.2	168.4	15115.0	6901.1			

CONSTRUCTION BUDGET (K\$/1980):

SUNK EQUITY COSTS = 3000.0
PROJECT CAPITAL COST = 15604.6
WORKING CAPITAL = 0.0

MINIMUM EQUITY FRACTION = 0.250
DOE FEE = 0.010

TOTAL (LESS FINANCING) = 18604.6

DOE FEE'S AND INTEREST = 3411.6

TOTAL CAPITAL COST = 22016.2

YEAR	INTEREST RATE	INVESTMENT BREAKDOWN	ANNUAL ** TAX LOSSES
1 - 1980	0.100	0.545	719.7
2 - 1981	0.100	0.273	1160.6
3 - 1982	0.100	0.182	1531.3

** - ANNUAL TAX LOSSES INCLUDE CONSTRUCTION PERIOD DRY HOLE EXPENSES, EXPLORATION COSTS, INTANGIBLE DRILLING COSTS, DOE FEES, AND INTEREST.

**FIGURE 2-9
CONSTRUCTION PERIOD WITH MINIMUM TOTAL EQUITY FRACTION OF
0.25 AND ANNUAL EQUITY FRACTIONS OF 0.25**

2.4.10 Tax Vs. No Tax

The model has the option to omit the payment of income taxes and receipt of tax benefits on any project. The purpose of this option is to examine the economic viability of operating a geothermal field or plant as a tax-exempt entity or as a limited partnership (in which the tax liabilities and benefits are passed directly to the limited partners) as compared to the viability of a corporation. Of course, the corporation tax rate may itself be adjusted to assess the relative economics of operation under different size companies. In the interactive session, the model asks the user: "Does the project pay income taxes? (Y or N)." The user then simply enters Y or N for Yes or No.

2.4.11 Sinking Fund Vs. No Sinking Fund

Similar to the tax question, the model allows the user the option of having or not having a sinking fund. The purpose of this option is to provide a set-aside fund to meet equipment replacement and related obligations. Without such a fund, the cash flow requirements tend to exhibit major fluctuations in years when such replacements occur.

In the interactive session, the model asks the user: "Do you wish to create a sinking fund? (Y or N)." The user simply enters Y or N for yes or no.

2.5 Statement of Extent of Testing

Testing a computer program of the complexity of the GLGP Cash Flow Model is an extremely difficult task. The nature of software packages is that testing must be performed under operating conditions. The model has been tested and refined to a level at which the error frequency has become very low, but as of September 1980, we cannot guarantee that the model is error-free.

2.5.1 Cycle Design Routine

The power plant cycle design and costing routine has been given extensive testing and found to give results generally close to a set of generic designs and costs estimated by J. R. Schilling for MITRE in 1976, (Schilling, 1976). The nature of the steam and isobutane thermodynamic equations used in GCFM is such that a 3-5% error in equipment size may be introduced when selecting the cycle design points.

The cycle design routine does not optimize. The default values used by the cycle design routine are intended to prevent the model from not working due to a lack of data, and as such they do not represent optimum values at any site. The design routine is intended to provide a "best guess" when little or no power plant data exists.

2.5.2 Power Plant Module

The power plant module is relatively straight forward. Aside from the cycle design routine this module only monitors a database

and initializes databases for the financial module.

2.5.3 Field Design Module

The Field Module is probably the most speculative among the three modules. The main reasons for this are:

- Highly site-specific nature of geothermal prospects,
- Default values based on empirical data derived from a limited number data values, and
- The lack of experience with geothermal wells and resources in general.

The default values are intended to provide a "best guess" when little or no other data is available.

Ideal results will occur when no defaults are required and all data needed are available to the user. The overall accuracy of the costs estimated by the design modules depends on how much data are generated by the program versus how much are supplied by the user.

2.5.4 Financial Module

The Financial Module is the most complex of the three modules. Discrepancies often arise in these types of calculations due to the methods used for calculation. For instance, this model uses year-end escalation and discounting whereas other programs have been written which use front-end or mid-year escalation.

The results of the financial analysis by the model will provide some indications regarding a borrower's ability to repay a DOE Guaranteed Loan. The various cash flow, market price and breakeven price reports are designed to provide specific information which,

taken together, provide a profile involving the potential health and competitiveness of a given project. For example, the cash flow report shows the projected streams of cash inflows each year, which is critical in determining a borrower's ability to meet his debt and other financial obligations. Also, the calculation of levelized breakeven prices for projects using the same desired return on equity will provide a ranking among those projects in terms of required selling prices. A more detailed discussion of the various financial calculations within the model is presented in Appendix A.

3.0 MODEL INPUT

3.1 Input Data Requirements

There are four sets of data which provide inputs to the three modules of GCFM. The relationship between these datasets and the three modules is shown in Table 3-1.

The following sections describe the variables in the sequence accepted by the model.

3.1.1 Input Data Format

The input parameters for the three modules are of three generic types:

- 1) Constants (time invariant)
- 2) Vectors (time variant)
- 3) Matrices (capital account-time variant)

3.1.1.1 Constants

When the parameters are constant, the data entry routine will indicate the number which should be entered. These values do not vary over time.

3.1.1.2 Vectors

Vectors are time variant sets of values. The number of elements in each vector is equal to the project life, i.e., there is one value per year. Values of this type are entered in specified ranges described by the following four subparameters:

TABLE 3-1
Data Sets for GCFM Modules

MODULE	DATA SET
Power Plant	Power Plant Cycle Design Data Power Plant Module Data
Field Module	Field Module Data
Financial Module	Financial Module Data

- 1) A base value
- 2) A linear rate of change
- 3) A start-year, and
- 4) An end-year.

Subparameters three and four describe the range, i.e., the time period during which subparameters one and two describe the value. Subparameter one, the base value, is the value which is entered in the first year of the range. Subparameter two, the rate of change, specifies the value which is added to the base value each year. These four values allow great flexibility in entering time variant data.

The following examples illustrate the procedure:

- 100 0 4 10

This set of values is equivalent to entering 100 for years 4 through 10.

- 100 5 15 20

This set of values is equivalent to entering 100, 105, 110, 115, 120, 125, in years 15 through 20.

- 100 -5 5 9

This set of values is equivalent to entering 100, 95, 90, 80 in years 5 through 9.

3.1.1.3 Matrices

The need for matrices arises when dealing with a time variant parameter related to capital cost, e.g., where the value in any year varies according to that portion of a project's capital costs to

which it applies. The input procedure here is a slightly modified version of the Vector procedure. The user first specifies which of the 5 capital account numbers (1,2,3,4,5) are to be entered. For example, the user selects the numbers 2 and 4; which represent escalation rates pertaining to the pumps and process equipment capital accounts, respectively. The model then prompts the user for the same 4 parameters specified in the vector data entry.

- 1) A base value
- 2) A linear rate of change
- 3) A start-year, and
- 4) An end-year.

The user then enters the following set of numbers:

• 0.10 0 4 10

The above sequence of numbers indicates the four years 4 through 10, the pumps and process equipment capital costs (account 2 and 4) will escalate at a constant rate of 10 percent per year.

3.2 Power Plant Cycle Design Routine Input Variables

3.2.1 Dry Steam Cycle

1. Temperature of Steam: The temperature of dry steam at the turbine inlet.

Range of Values: 400-600

Units: °F

Default: 400

2. Pressure of Steam: The pressure of dry steam at the turbine inlet.

Range of Values: ?

Units: PSI

Default: Assumed to be at saturation point for given temperature.

3. Gas Content: The noncondensable gas content of the dry steam.

Range of Values: 0.0-100.0

Units: Percent

Default: 0.0

4. Plant Net Sales Output: The net output of the power plant.

Range of Values: 10-150

Units: MWe

Default: 50.0

5. Generator Efficiency: The ideal load mechanical efficiency of the generator.

Range of Values: 95.0-100.0

Units: Percent

Default: 98.0

6. Turbine Efficiency: The expansion efficiency of the steam turbine.

Range of Values: 60-80

Units: Percent

Default: 67%

7. Turbine Outlet Temperature: The temperature of the water/steam mixture at the turbine outlet.

Range of Values: 100-125

Units: °F

Default: Calculated

8. Cooling Water Temperature: Temperature of cooling water entering the condenser. :

Range of Values: 80-100

Units: °F

Default: Calculated

9. Design Wet Bulb Temperature: The 95% value for wet bulb temperature at the location of the plant.

Range of Values: 60-80

Units: °F

Default: 65°

Note: See list of sites and wet bulb temperatures in Appendix.

10. Height of Cooling Tower: The height which water must be pumped to reach the sprays of the cooling tower.

Range of Values: 0-unlimited.

Units: Feet

Default: 40

11. Pump and Piping Material: The material of which the major pump casings and pipes are made. Either Carbon Steel or Stainless Steel.

Range of Values: 1 = Carbon Steel, 2 = Stainless Steel

Default: 1 = CS

Note: Impacts the cost (Stainless Steel is more expensive)

12. Pump Driver Types: Describes the power source for the major pumping equipment, either an electric motor or a small turbine

Range of Values: 1 = Electric motor, 2 = small turbine

Default: 1 = motor

Note: Impacts final turbine size (motor-driven pumping boosts electric parasitic load).

13. Cooling Tower Type: The type of cooling tower, wet or dry. Dry towers are more costly.

Range of Values: 1 = wet, 2 = dry

Default: 1 = wet

14. Cooling Tower Material: If the cooling tower is a wet tower, the material may be selected. Wood towers are cheaper.

Range of Values: 1 = wood, 2 = concrete

Default: 1 = wood

3.2.2 Single Stage Flash Cycle

1. Temperature of Unflashed Fluid: Temperature of unflashed fluid at flash tank inlet.

Range of Values: 350-550

Units: °F

Default: 400

2. Gas Content: The noncondensable gas content of the flashed steam.

Range of Values: 0.0-100.0

Units: Percent

Default: 0.0

3. Total Dissolved Solids - The total dissolved solids content of the unflashed fluid.

Range of Values: 0.0 - 1,000,000

Units: PPM (parts per million)

Default: 0.0

4. Plant Net Sales Output: The net output of the power plant.

Range of Values: 10-150

Units: MWe

Default: 50.0

5. Generator Efficiency: The ideal load mechanical efficiency of the generator.

Range of Values: 95.0 - 100.0

Units: Percent

Default: 98.0

6. Turbine Efficiency: The expansion efficiency of the steam turbine.

Range of Values: 60-80

Units: Percent

Default: 67%

7. Flash Tank Temperature: The temperature of the brine and steam in the flash tank.

Range of Values: Some value between temperature of unflashed fluid and turbine outlet temperature.

Units: °F

Default:
$$2\sqrt{(\text{Temp Unflashed Fluid}) \times (\text{Turbine Outlet Temperature})}$$

8. Turbine Outlet Temperature: The temperature of the water/steam mixture at the turbine outlet.

Range of Values: 110-125

Units: °F

Default: Calculated

9. Cooling Water Temperature: The Temperature of the cooling water entering the condenser.

Range of Values: 80-100

Units: °F

Default: Calculated

10. Design Wet Bulb Temperature: The 95% value for wet bulb temperature at the location of the plant.

Range of Values: 60-80

Units: °F

Default: 79°

Note: See list of sites and wet bulb temperatures in appendix.

11. Height of Cooling Tower: The height to which water must be pumped to reach the sprays of cooling tower.

Range of Values: 0 - unlimited

Units: feet

Default: 40

12. Pump and Piping Material: The material of which the major pump casings and pipes are made. Either Carbon Steel or Stainless Steel.

Range of Values: 1 = Carbon Steel, 2 = Stainless Steel

Default: 1 = CS

Note: Impacts the cost (Stainless steel is more expensive).

13. Pump Driver Types: The power source for the major pumping equipment; either an electric motor or small turbine.

Range of Values: 1 = Electric motor, 2 = Small turbine

Default: 1 = motor

14. Cooling Tower Type: The type of cooling tower, wet or dry. Dry towers are more costly.

Range of Values: 1 = wet, 2 = Dry

Default: 1 = Wet

15. Cooling Tower Material: If the cooling tower is a wet tower, the material may be selected. Wood towers are cheaper..

Range of Values: 1 = Wood, 2 = Concrete

Default: 1 = Wood

3.2.3 Dual Stage Flash Cycle

1. Temperature of Unflashed Fluid: Temperature of unflashed fluid at the inlet of the first flash tank.

Range of Values: 350-550

Units: °F

Default: 400

2. Gas Content: The noncondensable gas content of the flashed steam.

Range of Values: 0.0 - 100.0

Units: Percent

Default: 0.0

3. Total Dissolved Solids - The dissolved solids content of the unflashed fluid.

Range of Values: 0.0 - 1,000,000

Units: PPM

Default: 0.0

4. Plant Net Sales Output: The net output of the power plant.

Range of Values: 10 - 150

Units: MWe

Default: 50.0

5. Generator Efficiency: The ideal load mechanical efficiency of the generator.

Range of Values: 95.0 - 100.0

Units: Percent

Default: 98.0

6. High Pressure Turbine Efficiency: The expansion efficiency of the high pressure stage of the turbine.

Range of Values: 60-80

Units: Percent

Default: 73%

7. Low Pressure Turbine Efficiency: The expansion efficiency of the low pressure stage of the turbine.

Range of Values: 60-80

Units: Percent

Default: 67%

8. First Stage Flash Tank Temperature: The temperature of the brine and steam in the high pressure flash tank.

Range of Values: Some value between temperature of unflashed fluid and turbine outlet temperature.

Units: °F

Default:
$$\sqrt[3]{\left(\text{Temp Unflashed Fluid}\right)^2 \times \left(\text{Turbine Outlet Temperature}\right)}$$

9. Second Stage Flash Tank Temperature: The temperature of the brine and steam in the low pressure flash tank.

Range of Values: Some value between the first stage flash temperature and the turbine outlet temperature.

Units: °F

Default:
$$\sqrt[2]{\left(\text{First Stage Flash Temp.}\right) \times \left(\text{Turbine Outlet Temperature}\right)}$$

10. Turbine Outlet Temperature: The temperature of the water/steam mixture at the turbine outlet.

Range of Values: 110-125

Units: °F

Default: Calculated

11. Cooling Water Temperature - The temperature of the cooling water entering the condenser.

Range of Values: 80-100

Units: °F

Default: Calculated

12. Design Wet Bulb Temperature: The 95% value for wet bulb temperature at the location of the plant.

Range of Values: 60-80

Units: °F

Default: 79°

13. Height of Cooling Tower: The height which water must be pumped to reach the sprays of the cooling tower.

Range of Values: 0 - unlimited

Units: Feet

Defaults: 0

14. Pump and Piping Material: The material of which the major pump casings and pipes are made. Either Carbon Steel or Stainless Steel.

Range of Values: 1 = carbon steel, 2 = stainless steel,

Default: 1 = CS

Note: Impacts the cost (stainless steel is more expensive).

15. Pump Driver Types: Describes the power source for the major pumping equipment, either an electric motor or small turbine.

Range of Values: 1 = Electric motor, 2 = Small turbine

Default: 1 = Motor

Note: Impacts final turbine size (motor driven boosts electric parasitic load)

16. Cooling Tower Type: The type of cooling tower, wet or dry. Dry towers are more costly.

Range of Values: 1 = Wet, 2 = Dry

Default: 1 = Wet

17. Cooling Tower Material: If the cooling tower is a wet tower, the material may be selected. Wood towers are cheaper.

Range of Values: 1 = Wood, 2 = Concrete

Default: 1 = Wood

3.2.4 Brine/Binary Cycle (Isobutane)

1. Temperature of Unflashed Fluid. The temperature of unflashed fluid at the heat exchanger inlet.

Range of Values: 275-500

Units: °F

Default: 400°

2. Pressure of Unflashed Fluid. The pressure of unflashed fluid at heat exchanger inlet.

Range of Values:

Units: PSI

Default: Value on saturation line for given temperature.

3. Reinjection Temperature - Brine temperature at heat exchanger outlet.

Range of Values: 200-250

Units: °F

Default: Calculated

4. Reinjection Pressure - Brine pressure at heat exchanger outlet.

Range of Values: Some value less than or equal to the pressure at heat exchanger inlet.

Units: PSI

Default: Pressure at Heat Exchanger Inlet.

5. Total Dissolved Solids - The total dissolved solids content of the unflashed fluid.

Range of Values: 0.0 - 1,000,000

Units: PPM

Default: 0.0

6. Plant Net Sales Output: The net output of the power plant.

Range of Values: 10-150

Units: MWe

Default: 50.0

7. Generator Efficiency: The ideal load mechanical efficiency of the generator.

Range of Values: 95.0-100.0

Units: Percent

Default: 98.0

8. Turbine Efficiency: The expansion efficiency of isobutane turbine.

Range of Values: 70-90%

Units: Percent

Default: 85%

9. Working Fluid Temperature at Turbine Inlets: The temperature of the superheated isobutane at the turbine inlet.

Range of Values: 200-400

Units: °F

Default: 373

10. Working Fluid Pressure at Turbine Inlet: The pressure of the superheated isobutane at turbine inlet.

Range of Values: 1000-1800

Units: PSI

Default: 1600

11. Working Fluid Pressure at Turbine Outlet: The pressure of superheated isobutane at turbine outlet.

Range of Values: 70-100

Units: PSI

Default: 70

12. Cooling Water Temperature Condenser Inlet: The temperature of the cooling water as it enters the desuperheater/condenser.

Range of Values: 80-100

Units: °F

Default: Calculated

13. Cooling Water Temperature Condenser Outlet: The temperature of the cooling water as it leaves the desuperheater condenser.

Range of Values: 110-125

Units: °F

Default: Calculated

14. Design Wet Bulb Temperature: The 95% value for wet bulb temperature at the location of the plant.

Range of Values: 60-80

Units: °F

Default: 79

Note: See list of sites and wet bulb temperatures in Appendix.

15. Height of Cooling Tower: The height to which water must be pumped to reach the sprays of cooling tower.

Range of Values: 0 - unlimited

Units: feet

Default: 40

16. Pump and Piping Material: The material of which the major pump casings and pipes are made. Either Carbon Steel or Stainless Steel.

Range of Values: 1 = Carbon Steel, 2 = Stainless Steel

Default: 1 = CS

17. Pump Driver Types: The source for the major pumping equipment, either an electric motor or small turbine.

Range of Values: 1 = electric motor, 2 = small turbine

Default: 1 = motor

Note: Impacts final turbine size (motor-driven boosts electric parasitic load).

18. Cooling Tower Type: The type of cooling tower, wet or dry. Dry towers are more costly.

Range of Values: 1 = Wet, 2 = Dry

Default: 1 = Wet

19. Cooling Tower Material: If the cooling tower is a wet tower, the material may be selected. Wood towers are cheaper.

Range of Values: 1 = Wood, 2 = Concrete

Default: 1 = Wood

3.3 Power Plant Module Input Variables

The following definitions describe the input variables for the Power Plant Module. The number preceeding each variable indicates the variable number referenced by the change routine.

1. Base Year: The year the project begins. This is the first year of construction of the plant and is the year the loan guarantee begins. This variable is required.

Range of Values: 1960-2020
Number of Values: One
Units: Years
Default: 1979

! "WARNING"! This value must match the corresponding base year in the financial case if the financial case is to be run with this powerplant project.

2. Plant Cost Index: An index used to adjust the internal costing equations to account for increasing costs. The cycle design subroutine costs are calculated in 1979 dollars, and the cost index adjusts the costs to constant dollars in the base year. This is not a critical value, when the user provides his own costs.

Range of Values: Any non-zero, positive value
Number of Values: One
Units: Percentage
Default: 100 percent

Example: The user creates a power plant project which begins in 1981 (base year). He assumes that the annual increases of capital equipment costs for the years 1980 and 1981 are each 15 percent. Therefore, the cost equations in the design program may be updated by specifying a plant cost index of $(100 \times 1.15 \times 1.15) = 132.25\%$

3. Project Life: The sum of the construction period and the operating life of the project. This value is required.

Range of Values: 2-50 years
Number of Values: One
Units: years
Default: None

4. Power-On-Line Year: The year the power plant begins selling electricity. This value is required.

Range of Values: The difference between the base year and the power-on-line year may never be greater than nine. The plant must come on line within nine years of the project start.

Number of Values: One

Units: Years

Default: None

●!"WARNING"! The base year, power-on-line year, and project life are interrelated. They establish the time framework in which the model analyzes a project.

Consider the case where a developer proposed to begin a project in 1981 and plans to begin operation in 1986. Assume the operating life will be thirty years. From this information we can calculate the length of the construction period and the project life as follows:
Length of Construction period equals the power-on-line year minus the base year, e.g.: $5 \text{ (years)} = 1986 - 1981$

The project life equals the construction period plus the operating life, e.g.: $35 \text{ (years)} = 5 + 30$.

5. Power Plant Net Sales Output: The net power output of the plant. It is the amount of power supplied to the power grid at busbar. This value is required.

Range of Values: Non-zero, positive

Number of Values: One

Units: Megawatts electric (MWe)

Default: None

Comments: The power plant sales output is used to determine the gross revenues.

6. Power Plant Turbine Rating: The turbine rating is the gross output of the plant. This value is required.

Number of Values: One

Units: Turbine rating in megawatts electric (MWe)

Default: Calculated by the cycle design routine.

Comments: Note that the gross power output minus the power consumed by internal equipment equals the net sales output.

7. Brine Flow Required: The total amount of geothermal fluid which will produce the vapor required by the power plant to spin the turbine. This value is required.

Number of Values: One

Units: Thousands of pounds per hour (K/LB/hr)

Default: Calculated when Cycle Design Subroutine is executed.

8. Power Plant Capital Costs: Five categories of costs which represent each of the five capital accounts. The component costs are grouped into these five accounts according to similarity of asset life.

Number of Values: Five, one for each account.

Units: Thousands of dollars

Default: Calculated when Cycle Design Subroutine is executed.

9. Book Lives for Power Plant Capital Accounts: Effective usable life of assets, used to determine capital recovery and book depreciation.

Range of Values: Non-zero, positive values

Number of Values: Five, one for each of five capital accounts.

Units: Number of years

Default: A default value will be taken if the value of any of the variables is zero or negative. The defaults are as follows:

Account	1	2	3	4	5
Years	20	5	12	30	30

10. Tax Lives for Capital Accounts: The tax lives of the five capital accounts are used to calculate tax depreciation

Range of Values: Non-zero, using the sum of years digits methods positive values.

Number of Values: Five, one for each of five years capital accounts.

Units: Number of years

Default: A default value will be taken if the value of any of the variables is zero or negative. The defaults are as follows:

Account	1	2	3	4	5
Years	20	5	12	30	30

11. Salvage Rates for Utility Capital Accounts: Fractions representing the end-of-life salvage values for the power plant capital accounts.

Range of Values: 0-1.0

Number of Values: Five, one for each of the five capital accounts

Units: Fractions

Default: 0.0

12. Overhead and Maintenance Costs (O&M) for Power Plant Capital Accounts: A fraction of the total cost of each of the five capital accounts which represents the annual O&M costs for that account.

Range of Values: 0-1.0

Number of Values: Five, one for each of five capital accounts.

Units: Fraction

Default: 0.0

13. Other Operating Costs: The annual operating costs not covered by the O&M costs relating to the five capital accounts.

Range of Values: Zero or positive values

Number of Values: A value is entered for each year of the operating life. Values corresponding to the construction years have no impact and non-zero values will be ignored.

Units: thousands of dollars

Default: 0.0

Example: Suppose an application specified O&M costs as a lump sum instead of as a fraction of capital costs. The O&M cost fractions may be left blank and the annual O&M costs entered as other operating costs.

14. Sunk Costs: The total value of expenditures of the power plant developer prior to the beginning of project spending of funds from DOE's guaranteed construction loan. This value is treated as a 100 percent equity investment for purposes of determining the debt/equity ratio.

Number of Values: One

Units: Thousands of dollars

Default: 0.0

15. Capital Investment Breakdown: The fraction of the total capital costs of a plant which will be invested during each construction year. These values are required.

Range of Values: 0-1.0, the total of all values must equal one.
If not, the program will prorate those values given.

Number of Values: 1-9. A value must be given for each year of the construction period. Note, however, that any year may contain a zero value.

Units: Fraction

Defaults: As follows: (See Table 3-2)

Comments: As long as one of the values given are not zero, no defaults will be taken.

Example 1: If a three year construction period exists, and the values .25, .25, and .50 are given, then one quarter of the capital costs will be spent the first and second years, with the last half being spent the third year.

Example 2: If the user does not want any capital spent in the second construction year, he may use values such as .25, 0, 0.75. This would indicate that no work was performed during the second year of the construction period.

Example 3: Given a three year construction period, if the values 1, 2, and 3 are entered, the program will correct them by prorating the values, One-sixth would be used for the first value, .33 for the second, and .50 for the third.

TABLE 3-2

CAPITAL INVESTMENT BREAKDOWN (EXAMPLES)

Year	FIELD		POWER PLANT	
	Investment (\$10 ⁶ /Yr)	Fraction of Total	Investment (\$10 ⁶ /Yr)	Fraction of Total
1	10	.2	0	.0
2	20	.4	0	.0
3	10	.2	5	.1
4	5	.1	15	.3
5	5	.1	30	.6

3.4 Field Module Input Variables

The following definitions describe the input variables for the Field Module of GCFM. The number preceeding each variable indicates the variable number referenced by the change routine.

1. Base Year: The year the project begins e.g. the year the guaranteed loan beings to be drawn down. This variable is required.

Range of Values: 1960-2020

Number of Values: One

Units: Years

Default: 1979

!WARNING! This value must match the corresponding base year in the financial case if the financial case is to be run with this field case.

2. Plant Cost Index: An index used to adjust the internal costing equations to account for increasings costs. All internal program costs are calculated in 1979 dollars, and the cost index adjusts the costs to current year dollars. This is not a critical value, when the user provides his own costs. But it is important when costs are calculated by the design program.

Range of Values: Any non-zero, positive value

Number of Values: One

Units: Percentage

Default: 100%

Example: The user creates a field development project which begins in 1981 (base year). He assumes that the annual increases of capital equipment costs for the years 1980 and 1981 are each 15%. Therefore, the cost equations in the design program may be updated by specifying a cost index of $(100 \times 1.15 \times 1.15) = 132.25\%$.

3. Project Life: The sum of the construction period and the operating life of the project. This value is required.

Range of Values: 2- 50 years

Number of Values: One

Units: Years

Default: None

4. Power-On-Line Year: The year the field begins selling geothermal fluid to the power plant. This value is required.

Range of Values: The difference between the base year and the power-on-line year may never be greater than nine: the plant must come on line within nine years of the project start.

Number of Values: One

Units: Years

Default: None

Project Time Framework: The base year, power on line year, and project life are interrelated. They establish the time framework in which the model analyzes a case.

Consider the case where a developer proposed to begin development of a field in 1981 and plans to begin operations in 1986. Assume the operating life will be thirty years. From this information we can calculate the length of the construction period as follows:

Length of construction period = Power on line year - base year) e.g.
(5 years) = 1986-1981

The project life is defined as the construction period plus the operating life. Therefore:

Project life = construction period + operating life
(35 years) = 5 + 30

5. Power Plant Type: The type of power plant to which the field will supply geothermal fluid (brine). The two types of power plants are steam and binary.

Range of Values: 1 = steam; 2 = binary

Number of Values: One

Default: 1 = steam

Comments: The steam/binary distinction in this case refers to the type of vapor used to drive the turbine. If steam is used, the turbine is assumed to be driven by water vapor. In the binary case, the turbine is assumed to be driven by the vapor of a secondary working fluid, such as isobutane.

6. Field Output: The electricity equivalent of the field production. This value is used in the field revenue calculations.

This value is required.

Range of Values: Non-zero, positive value

Number of Values: One

Units: Megawatts electric (MWe)

Default: None

Comments: It is left to the user to decide whether the revenue accruing to the field developer is based on usable (net MWe) or total (gross MWe) capacity.

7. Field Electricity Consumption: The electric capacity (parasitic losses) used by the field to run the pumps and other equipment in the production of geothermal brine.

Range of Values: Non-zero, positive value

Number of Values: One

Units: Megawatts electric (MWe)

Default: If down hole pumps are used the design program calculates a default as needed.

Comments: If the field electricity consumption is zero, the field will have no fuel requirement.

8. Brine Flow Required: The total brine required by the power plant to provide the necessary thermal energy required to run the plant. This value is required.

Range of Values: Non-zero, positive value

Number of Values: One

Units: Thousands of pounds per hour (K Lb/hr)

Default: Zero

Comment: This value is calculated in the power plant module by the plant cycle design routine. If this default is to be used by the field module, the value must be entered by the user.

9. Resource Depth: The depth which must be drilled to enter the geothermal reservoir. This variable is required if default values for well flows and/or well costs are to be calculated.

Range of Values: Non-zero, positive value

Number of Values: One

Units: Feet

Default: 0.0

10. Salinity: The quantity of dissolved solids contained in the brine as it is extracted from the reservoir.

Range of Values: 0 - 1,000,000 (PPM)

Number of Values: One

Units: Parts per million (PPM)

Default: 0.0

11. Rock Hardness: The hardness of rock overlaying the geothermal reservoir. This value is required if default values for well costs are to be calculated.

Range of Values: 1 = soft; 2 = medium; 3 = hard

Default: 1 = soft

Comment: "Hardness" should be interpreted as the average "drillability" of the formation, from the viewpoint of a drilling operator.

12. Resource Temperature: The temperature of the brine at the wellhead. This value is required if the non-well related field capital costs are to be calculated or if the design program determines the need for down hole pumps.

Number of Values: One
Units: Degrees Fahrenheit (^oF)
Default: 0.0

13. Well Flow Rates: The flow rate of fluids from the production and injection wells.

Range of Values: Non-zero, positive values

Number of Values: Two - a flow rate must be given for both the production and injection wells, respectively.

Units: Thousands of pounds per hour (K lbs/hr)

Defaults: The default values are calculated by the model. Valid data must be entered for the resource Depth variable (#9), before these default values can be calculated.

Example: Valid data for well flow rates could be: 100 200. These values represent 100 K lbs/hr and 200 K lbs/hr, respectively.

14. Total Cost of Wells: The cost of production wells and injection wells.

Number of Values: Two - one for production wells and one for injection wells, respectively

Units: Thousands of dollars

Defaults: Values are calculated on a cost per well basis. If defaults are to be calculated input values must be defined for the Resource Depth (#9) and the Rock Hardness (#11).

Comments: If the design routine is to determine whether deep well pumps are necessary, valid input data must be specified for the Salinity (#10), Plant Type (#5), and Resource Temperature (#12) variables.

!WARNING! A distinction must be made between well costs which are entered through the input routine and those entered through the change routine. The input routine accepts data for the well costs on a cost per well basis. The change routine accepts two values which represent the total costs of production and injection wells, respectively.

15. Total Cost Per Downhole Pump: The cost of each downhole pump. This value is necessary if the total cost of downhole pumps are to be calculated.

Number of Values: One

Units: Thousands of dollars

Default: 250

●**!WARNING!** A distinction must be made between downhole pump costs which are entered through the input routine and those entered through the change routine. The input routine accepts data for the downhole pump costs on a cost per downhole pump basis. The change routine accepts two values which represent the total costs of production and injection pumps, respectively.

16. Downhole Pump Switch: A code specifying how the design program is to consider the use of downhole pumps.

Range of Values: 1 = no downhole pumps used
2 = downhole pumps will be used when the design routine determines a need for them
3 = downhole pumps will always be used

Number of Values: One

Default: 2 - downhole pumps will be used when the design routine determines a need for them.

Comments: If the Downhole Pump/Switch variable is equal to 2, the design routine selects the use of down well pumps in the following circumstances.

- (1) If the plant type is 2 (binary), or
- (2) If an insufficient well flow occurs as a result of a drop in pressure while bringing the resource to the surface. This calculation requires valid data for salinity, resource depth, and resource temperature.

17. Book Lives of Wells and Downhole Pumps: The usable lives of production wells, injection wells, and down well pumps.

Range of Values: 1 - 50 years

Number of Values: three; one for each of the following: production wells, injection wells, and down well pumps, respectively.

Units: years

Defaults: A default value is taken if the value given for any of the variables is zero or negative. The defaults are as follows:

<u>CAPITAL ACCOUNT</u>	<u>ACCOUNT DESCRIPTION</u>	<u>DEFAULT VALUES</u>
1	Production Wells	10 Years
2	Injection Wells	10 Years
3	Down Well Pumps	5 Years

Notice: See Additional Explanation under Variable #24, this section.

18. Tax Lives of Wells and Downhole Pumps: The lives of production wells, injection wells, and downhole pumps, which are used to calculate tax depreciation.

Range of Value: 1 - 50 years

Number of Values: Three, a value is given for production wells, injection wells, and downhole pumps, respectively.

Units: years

Defaults: A default value is taken if the value given for any of the variables is zero or negative. The defaults are as follows:

<u>CAPITAL ACCOUNT</u>	<u>ACCOUNT DESCRIPTION</u>	<u>DEFAULT VALUES</u>
1	Production Wells	6 Years
2	Injection Wells	6 Years
3	Downhole Pumps	5 Years.

19. Salvage Rates: Fractions which represent the end-of-life salvage values for production wells, injection wells, and down well pumps. These fractions are applied to the cost of the wells and pumps.

Range of Values: 0-1.0
Number of Values: Three, one for each, production wells, injection wells, and down well pumps
Units: Fraction
Defaults: 0.0

20. Overhead and Maintenance Rates (O&M): A fraction of the capital costs of production wells, injection wells, and downhole pumps which represent the annual O&M costs for the equipment.

Range of Values: 0-1.0
Number of Values: Three, one for each, production wells, injection wells, and down well pumps
Units: Fraction
Defaults: 0.0

21. Intangible Drilling Cost Rates: Fractions of production and injection well costs which will be expensed (treated as an operating expense).

Range of Values: 0-1.0
Number of Values: Two, one for both production wells and injection wells
Units: Fraction
Defaults: 0.0
Comments: Expensing is advantageous since costs can be recovered during the year in which they are incurred. However, capitalized costs must be recovered by depreciation over a fixed period of time.

22. Drilling Success Ratio: A fraction representing the number of drilling attempts which resulted in successful production wells. This value is required.

Range of Values: Non-zero value less than 1.0.
Number of Values: A value must be specified for each of the years of the project life.
Units: Fraction
Default: In the case of a zero or negative entry, a default value of 1.0 will be used.
Comments: An annual success ratio will correspond to each of the years in the project life.
Example: If a given annual drilling success ratio is .9, then 90% of all production wells attempted in that year resulted in producing wells and the remaining 10% were dry holes.

23. Cost per Makeup Well: The cost of each additional production well which must be added to makeup for fiel decline.

Number of Values: One

Units: Thousands of Dollars

Default: 0.0

Note: Makeup well costs are treated as production wells for the purposes of escalation, investment tax credits, intangible drilling costs, well drilling success ratio, and depreciation.

Notice: See Additional Explanation under Variable #24.

24. Number of Makeup Wells: A series of values representing the annual number of additional production wells which must be added to makeup for field decline.

Range of Values: 0+, will accept fractional values.

Number of Values: A value may be specified for each year of the operating life

Units: Fraction

Defaults: 0.0

Additional Explanation: Additional makeup or replacement wells can be handled in one of two ways:

I. If variable #17 is used with a book life less than the project life, replacement of wells will be made in the year required by the book life. The cost of those wells will be incurred in that year, or spread over the previous years if the sinking fund option is used.

II. If the book life of the wells is set equal to the project life, so that no additional wells will be added, except those called for by Variable #24, which accepts the user's more realistic schedule of well replacement. When this approach is used, the total cost of each makeup well will be incurred in the year designated by the schedule of well replacement.

25. Field Plant Capital Costs: The non-well related capital costs associated with development of a geothermal field.

Number of Values: Two, one for each of two general equipment accounts (#4 and #5). When defaults are taken account #4 represents the distribution system, instrumentation and controllers, separators, and other process equipment. Account #5 represents the Engineering and Administration during construction.

Units: Thousands of dollars

Default: If defaults are to be calculated by the design program, values must be supplied for these variables: Plant Type (#5), Field Output (#6), Resource Temperature (#12), and Salinity (#10). Defaults will only be taken if the values for both accounts are less than or equal to zero.

26. Book Lives for Field Capital Accounts #4 and #5: Effective usable life of capital assets which is used to determine capital recovery and book depreciation.

Range of Values: Non-zero, positive value

Number of Values: Two, one for each of two general equipment accounts.

Units: Number of years

Default: 20 and 30 years, respectively. Zero and negative values will be replaced with default values.

27. Tax Lives for Field Capital Accounts: The tax lives of the two non-well capital accounts.

Range of Values: Non-zero, positive value

Number of Values: Two, one each for each of the non-well capital accounts.

Units: Number of years

Default: 20 and 12 years, respectively. These values will replace non-zero and negative entries.

28. Salvage Rates for Field Capital Accounts: Fractions representing the end of life salvage values for the non-well related field capital accounts.

Range of Values: 0-1.0

Number of Values: Two, one for each of the non-well related field capital accounts

Units: Fractions

Default: 0.0

29. Overhead and Maintenance Costs (O&M) for Field Capital Accounts #4 and #5: A fraction of the Capital Costs of non-well field equipment which represents the annual O&M costs for the equipment.

Range of Values: 0 - 1.0

Number of Values: Two, one for each account

Units: Fraction

Defaults: 0.0

30. Field Exploration Costs: The amount the developer expects to spend for exploration or reservoir definition during field construction.

Number of Values: One

Units: Thousands of dollars

Default: 0.0

31. Other Operating Costs: The annual operating costs not covered by the O&M costs relating to the five capital account categories costs for the five capital accounts.

Range of Values: Non-zero, positive value

Number of Values: A value is entered for each year of the operating life. Values corresponding to the construction years have no impact and should be entered as zero.

Units: Thousands of dollars

Defaults: 0.0

Example: Suppose an application specifies O&M costs as a lump sum instead of a fraction of capital costs. The O&M cost fractions may be left blank and the annual O&M costs entered with Other Operating Costs.

32. Sunk Costs: The total value of expenditures of the field developer prior to the execution of the loan guarantee or drawdown of guaranteed funds. This value is treated as a 100% equity investment for purposes of determining the loan equity fraction.

Number of Values: One

Units: Thousands of dollars

Default: 0.0

33. Capital Investment Breakdown: The fractions of the total capital cost of the field which will be invested during each construction year. These values are required.

Range of Values: 0 - 1.0. The sum of all values must equal one. If not, the program will prorate those values given.

Number of Values: 1-9. A value must be given for each year of the construction period.

Units: Fractions

Defaults: As follows:

Comments: As long as some of the values given are not zero, no defaults will be taken.

Example 1: If the values, 1, 2, and 3 are entered, the program will correct them by prorating the values. One-sixth would be used for the first value, .33 for the second, and .50 for the third.

Example 2: Capital investment breakdown is used as follows: If a three year construction period exists, and the values .25, .25, and .50 are given, then one-quarter of the capital costs will be spent the first and second years, with the last half being spent the third year.

Example 3: If the user does not want any capital spent in the second construction year, he may use values such as .25, 0, .75. This would indicate that no work was performed during the second year of the construction period.

3.5 Financial Module Input Variables

The following information describes the input variables used in the Financial Module. The number preceeding each variable indicates the variable number referenced by the change routine.

1. Base Year: The year the project begins and in which the loan guarantee begins. It is also the first construction year.

This value is required.

Range of Values: 1960-2020

Number of Values: One

Units: Years

Default: 1979

● **!WARNING!** This value must be equivalent to the base year used in the field or power plant project when either of those cases are run with the financial module.

2. Power On-Line Year: The year the field/plant starts operations and begins receiving revenue from the sale of fluid or electricity.

This variable is required.

Range of Values: 1961-2029; values must be within one to nine years greater than the base year.

Number of Values: One

Units: Year

Default: None

Comments: The construction period is determined by subtracting the power-on-line year from the base year. The construction period cannot exceed nine years.

● **!WARNING!:** The power-on-line year used by the financial module must be equal to the power-on-line year used in the corresponding field or power plant module run with the financial module.

3. Project Life: The overall life of the project defined as the sum of the construction period and the operating life.

This value is required.

Range of Values: 2-50 years

Number of Values: One

Units: Years

Default: None

4. Loan Life: The period of time during which an outstanding loan balance exists:

Range of Values: 2-50 years

Number of Values: One

Units: Years

Default Value: The value of the project life.

Comments: The loan life is specified separately from the project life to allow more flexibility in the design of the financial structure of the plant.

5. Working Capital: A sum of money added to the cost of the project to provide funds to begin operations. Sometimes, in the market price case, early project years will have negative cash flows. A working capital balance provides a reserve to cover these negative flows.

Range of Values: Zero or Positive Value

Number of Values: One

Units: Thousands of dollars

Default: 0.0

Comments: The working capital investment occurs during the fourth quarter of the last construction year. In the market price case, if the cash flows are negative in the first few years, the project will not suffer bankruptcy if the sum of the negative cash flows does not exceed the amount of working capital.

Example: The following examples A & B demonstrate how working capital influences the success or failure of a project (see Table 3-3).

6. Electricity Price: The market price of electricity expressed in current base year dollars. This value is required.

Range of Values: The electricity market price should be greater than one fluid market price.

Number of Values: One

Units: Mills per kilowatt hour (mills/kWh)

Default: 50 mills per kilowatt hour

7. Fluid Price: The market price of geothermal fluid expressed current in base year dollars. This value is required.

Range of Values: This value must be less than the electricity price.

Units: Mills per kilowatt hour (mills/kWh)

Default: 20 mills per kilowatt hour

8. Capacity Factor: The fraction of each year of project life during which the power plant field is on-line and generating electricity for revenue.

TABLE 3-3

WORKING CAPITAL EFFECT ON PROJECT FAILURE OR SUCCESS

	YEAR	NET CASH FLOW (\$K)	SUM OF NET CASH FLOW	WORKING CAPITAL AT BEGINNING OF YEAR	WORKING CAPITAL AT END OF YEAR
CASE A Startup	3	-1500	-1500	3000	1500
	4	-1200	-2700	1500	300
	5	-400	-3100	300	-100
CASE B Startup	3	-1500	-1500	4000	2500
	4	-1200	-2700	2500	1300
	5	-400	-3100	1300	900
	6	+400	-2700	900	No longer needed

Range of Values: 0-1.0

Number of Values: One value is required for each year of the project life.

Units: Fraction

Default: 0.0 during construction years; 1.0 during entire operating life

● **!WARNING!** The capacity factor must be zero during the construction period and should not be zero during the operating life.

9. Minimum Equity Fraction of Total Investment: The minimum portion of the capital cost of development which must be supplied by the developer in the form of equity.

Range of Values: 0-1.0

Number of Values: One

Units: Fraction

Default: .25

Comments: Note that this is not the same as the annual equity fractions. The minimum equity fraction represents an overall limitation on the amount of the borrower's risk capital (equity) during the construction period.

10. Annual Equity Fractions: A fraction representing the minimum required equity contribution to capital investment in any given construction year. Not to be confused with the minimum equity fraction of total investment.

Range of Values: 0-1.0

Number of Values: From one to nine values should be provided. One for each construction year.

Units: Fraction

Default: 0.0

11. Equity Rate of Return: The desired rate of return on equity which reflects the breakeven level of operation. The equity rate of return is used to calculate the annual breakeven prices in the breakeven price calculation.

Range of Values: 0-1.0

Number of Values: A value must be given for each year of the operating life of the plant.

Units: Fraction

Default: 0.0

Comments: The equity rate of return is multiplied by the equity in the project to determine the cash flow required. This result is used to calculate the breakeven price.

12. Principal Payments on Debt: The annual debt retirement payments made during the project operating life.

Number of Values: One value for each year of the loan life of the project.

Units: Thousands of dollars

Default: Equal principal payments for the length of time the power-on-line year and the end of the loan life.

Example: Consider a project whose base year is 1979 and power-on-line year is 1982. The project life and loan life are assumed to be 33 and 30, respectively. The construction period therefore, is three years.

The plant begins operating in 1982 and continues through 2012. Note that in 1982 the debt has twenty-seven years of life remaining while the plant has thirty years left. The default for each principal repayment will be $1/27$ th of the initial debt balance at power-on-line. Note that during the final three years the loan has been fully paid up and retired.

13. Debt Interest Rate: Interest rate on the loan.

Range of Values: 0.1.0

Number of Values: A value should be given for each year of the life of the loan.

Units: Fraction

Default: 0.0

14. Department of Energy (DOE) Fee Rate: Portion of the annual average outstanding loan balance which must be paid to DOE to cover administration and build-up fund available for defaults.

Range of Values: 0-1.0

Number of Values:

Units: Fraction

Default: 0.010

15. Sinking Fund Deposits: The minimum amount of money to be deposited in an account used to accumulate capital for replacement equipment. If no sinking fund is being used, this variable may be ignored.

Number of Values: A value should be given for each operating year.

Units: Thousands of dollars

Defaults: Defaults are calculated by financial module, and are intended to accumulate sufficient funds for all future replacements.

16. Sinking Fund Interest Rate: The rate of return on the accumulated capital in the sinking fund.

Range of Values: 0-1.0

Number of Values: One

Units: Fraction

Default: .10

17. General Inflation Rate: The escalation rate for other operating costs and salvage values.

Range of Values: 0-1.0

Number of Values: One

Units: Fraction

Default: 0.0

18. Escalation Rate for Capital Costs: Rates reflecting the increase in the costs of capital accounts.

Range of Values: 0-1.0

Number of Values: One

Units: Fraction

Default: 0.0

Comments: Each capital account has a separate annual escalation factor. See Capital Accounts Variables.

19. Escalation Rate for Market Price of Electricity: A rate which reflects the annual change in the market price of electricity.

Range of Values: 0-1.0

Number of Values: One for each year of the project life.

Units: Fraction

Default: 0.0

Comments: This value should be zero if a fixed price is assumed. Using zeroes during the construction years will result in the price of electricity not being escalated until the first year of operation.

20. Escalation Rate for the Fluid Price: A rate which reflects the annual change in the market price of geothermal fluid.

Range of Values: 0-10

Number of Values: One for each year of the project life.

Units: Fraction

Default: 0.0

Comment: This value should be zero if a fixed price is assumed. Using zeroes during the construction years will result in the price of geothermal fluid not being escalated until the first year of operation.

21. Escalation Rate of Overhead and Maintenance (O&M) Costs: Rate which reflects the annual change in O&M cost.

Range of Values: 0-1.0

Number of Values: One for each year of the project life.

Units: Fraction

Default: 0.0

Comment:

22. Discount Rate: The rate at which cash flows are discounted to levelize the break-even prices and to determine the discounted cash flow rate of return at a given market price.

Range of Values: 0-1.0

Number of Values: one value should be given for each year of the project life.

Units: Fraction

Defaults: 0.0

23. State Property Tax Rate: The rate at which property taxes are assessed on the assets of the project

Range of Values: 0-1.0

Number of Values: One for each year of the project life.

Units: Fraction

Default: 0.0

Comment: No property taxes are assessed during the construction period. The values entered for these years will be ignored.

24. Royalty Rate: The portion of revenue paid as royalties.

Range of Values: 0-1.0

Number of Values: One

Units: Fraction

Default: 0.0

25. Federal Income Tax Rate: Rate of federal income tax paid on income earned by the project.

Range of Values: 0-1.0

Number of Values: One

Units: Fraction

Default: 0.0

26. State Income Tax Rate: Rate of state income taxes paid on income earned by the project.

Range of Values: 0-1.0

Number of Values: One

Units: Fraction

Default: 0.0

Example:

27. Federal Tax Credit Rate: Rates for each of the five capital accounts representing the fraction of any annual investments which may be taken as an investment tax credit.

Range of Values: 0-1.0

Number of Values: One value for each year of project life for each capital account.

Units: Fraction

Defaults: 0.0

Example:

28. Depletion Allowance Rate: The fraction of revenue that may be deducted from income taxes as an allowance for depletion of the geothermal resource.

Range of Values: 0-1.0

Number of Values: One for each year of the operating life of project

Units: Fraction

Defaults: 0.0

Blank

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4.0 INTERACTIVE SESSIONS

GCFM is a fully interactive model which allows the user to estimate costs and perform life cycle costing on selected geothermal projects. The interactive capability allows the user to display or change data in any of a number of power plant projects, field projects, or financial cases.

Those projects and financial cases are each stored by one of the three modules under keyword names supplied by the user at creation time. The user calls up any given project by entering the keyword as requested by the model. These interactive features of the model allow easy creation of new projects and deletion of old ones.

This section includes listings of sample interactive runs for the three modules, to give the user an idea what the program input requirements are, as well as the sequence of events. The following paragraphs explain some of the important characteristics of each run.

The data used in the examples are shown on the data record sheets in Figures 4-2, 4-5, 4-7, and 4-10 and are used here to demonstrate the creation of new power plants, fields, and financial cases. Section 5.0 consists of explanations of the output generated by the model using the data in these sample runs.

Each power plant, field or financial case name represents a data set of the specific type. The power plant cycle design data set name corresponds to that power plant project of that same name.

At execution a data set under a given type and name is either new or old. A data set is new if there is no existing data under the name entered. If this is the case, a data entry routine prompts the user for the required data. When the data set is old the user has the option of changing any or all of the parameters.

The normal steps in the processing of data are:

1. Creation of a data set for a particular project by running the Field or Power Plant module,
2. Creation of a data set for financial calculations, and
3. Execution of the financial module for the design and the financial case.

After these three steps have been taken it is possible to change any of the parameters in the data sets and reexecute the programs to obtain new results that reflect these changes. This allows the user to do sensitivity studies in order to assess the impact one or more parameter variations.

The user should note that the financial module should not be executed unless either the power plant module or field plant module has been run. The financial routine requires data generated by either of the design modules to execute properly.

The Financial cases are designed to be "generic" in the sense that with minor restrictions any financial case may be run against any project. The only restrictions are as follows:

1. The Base years of the project and financial case must be equal.
2. The power-on-line years of the project and financial case must be equal.

3. The project lives of the project and financial case must be equal.

There will be given additional explanation later.

When a data set is being created (new data set) GCFM describes the parameter(s) that is to be entered and indicates the maximum number of values which are needed. By answering the questions displayed by GCFM the user can create a new data set.

When a data set is old and changes are to be made to its contents, GCFM displays a menu of variables which can be selected for changes. Each variable in the menu is identified by a number, a description and the number of elements. To change the contents of any variable, enter its number and hit "Return". GCFM will display the current contents of that variable and indicate the maximum number of values needed and the manner in which they should be entered.

Multiple entries of numeric values must be separated by one or more blank spaces. The data are actually "entered" only after the return key on the terminal has been depressed. See Section 3.1 for further details on data entry.

4.1 Start Execution

Figure 4-1 shows a complete interactive terminal session involving runs of the Field and Financial modules using existing data. In this run no changes were made to the existing data. The financial module produces only printed output; none appears on the terminal screen.

The following subsections describe more complex GCFM sessions. The name "sample" has been chosen as the name for this set of runs.

R: T=0.01/0.02 14:34:20

gcfm

DMSLIO740I EXECUTION BEGINS...

WELCOME TO THE GEOTHERMAL LOAN GUARANTY CASH FLOW MODEL.

MODULES AVAILABLE

1 = POWER PLANT DESIGN MODULE

2 = FIELD DESIGN MODULE

3 = FINANCIAL MODULE

ENTER NUMBER OF MODULE DESIRED?

?

2

CURRENT FIELD NAMES:

IMEPIAI-X

TEST/V3.0

EASELINE

DEMO

SAMPLE

T1

MARK

BRAW

FTEST

TESTOR

ENTER FIELD NAME (UP TO 20 CHARACTERS).

test/v3.0

A FIELD ALREADY EXISTS UNDER THAT NAME.

DO YOU WISH TO DELETE IT? (Y OR N)

n

DO YOU WISH TO CHANGE ANY FIELD DESIGN PARAMETERS? (Y OR N)

n

GLGP CASH FLOW MODEL

FIELD DESIGN & CAPITAL COST REPORT

FIGURE 4-1
SAMPLE GCFCM RUN

DO YOU WISH TO PERFORM FINANCIAL CALCULATIONS
BASED ON THE-TEST/V3.0
FIELD DESIGN? (Y OR N)

Y
CURRENT FINANCIAL CASE NAMES:
BASELINE
DEMO
KEN
TEST1
GELCON
NEW
SAMPLE
HARK
BRAW
TESTOR
GEYSER
TPC-GEYSER
IMPERIAL-X
ENTER FINANCIAL CASE NAME (UP TO 20 CHARACTERS).

demo
A FINANCIAL CASE ALREADY EXISTS UNDER THAT NAME.

DO YOU WISH TO DELETE IT? (Y OR N)

n
DO YOU WISH TO CHANGE THE FINANCIAL INPUT PARAMETERS? (Y OR N)

n
DO YOU WISH TO PERFORM A FINANCIAL ANALYSIS? (Y OR N).

Y
DO YOU WISH TO CREATE A SINKING FUND? (Y OR N)

Y
DOES THE PROJECT PAY INCOME TAXES? (Y OR N)

Y
ENTER FINANCIAL CASE NAME (UP TO 20 CHARACTERS).

ENTER FIELD NAME (UP TO 20 CHARACTERS).

WELCOME TO THE GEOTHERMAL LOAN GUARANTY CASH FLOW MODEL.
MODULES AVAILABLE

1 = POWER PLANT DESIGN MODULE

2 = FIELD DESIGN MODULE

3 = FINANCIAL MODULE

ENTER NUMBER OF MODULE DESIRED?

?

THANK YOU FOR USING GCFM

R; T=11.42/17.76 14:37:42

FIGURE 4-1
SAMPLE GCFM RUN
(CONCLUDED)

These cases represent fictional data and are for demonstration purposes only.

To begin execution of the model, the user should log on to the computer, and then enter the keyword "GCFM" (see Figure 4-1). The program will respond with a menu of the modules available to the user.

4.2 Power Plant Module

4.2.1 New Power Plant

The power plant module, unlike the other two modules, consists of two distinct parts. The main portion is analogous to the field module while the second is a special auxiliary Cycle Design Routine. The use of the Cycle Design Routine is optional but is required if Power Plant default values are desired.

The power plant cycle design routine is entered from within the power plant module. Figure 4-2 shows the data record sheet for the "sample" power plant design. Note the four types of cycle designs which the routine will use in its calculations and the variation in data requirements. However, it should be noted that if the cycle design routine is not used the user will be required to input the turbine rating, brine flow requirement and the capital costs. The execution of the cycle design routine generates values for these variables.

The flow of the creation of a power plant design varies only slightly with respect to the use of the cycle design routine.

GLGP Cash Flow Model
Data Record Sheet - CYCLE DESIGN

CASE NAME: Sample

RUN DATE: _____ RUN TIME: _____ RUN NUMBER: _____

	DRY	SINGLE	DOUBLE	BRINE	
	STEAM	FLASH	FLASH	EINARY	DEFAULT
Well Head Temp.				450.	400.0
Well Head Pres.				430.	Calc.
Brine Injection Temp.				234.	Calc.
Brine Injection Pres.				370.	Calc.
Gas Content (%)					1.0
Disolved Solids (PPM)				0.	14000
Net Sales Output (MWE)				50.	50.0
Generator Efficiency (%)				90.	98.0
Turbine Efficiency (%)				75.	75.0
Turbine Efficiency - L.P.					75.0
Flash Tank Temp.					Calc.
Flash Tank Temp. - L.P.					Calc.
W.F. Temp. - Turb. Inlet				373.	373.0
W.F. Pres. - Turb. Inlet				1600.	1600.0
W.F. Pres. - Turb. Outlet				70.	70.0
Turbine Outlet Temp.					125.0
Cooling Water Temp.				90.	90.0
Condenser Outlet Temp.				101.	115.0
Design Wet Bulb Temp				80.	79.0
Height of Cooling Tower				40.	40.0
Pump & Piping Material				2	1 (CS)
Pump Driver Type				1	1 (motor)
Cooling Tower Type				1	1 (wet)
Cooling Tower Material				1	1 (wood)

FIGURE 4-2
CYCLE DESIGN ROUTINE INPUT SHEET

Figure 4-3 shows these interactions. Note that the answer to the question: "Do you wish to use the Power Plant Cycle Design Routine? (Y or N)," was "yes". If the answer had been "no", the cycle design routine would have been bypassed. The next prompting would have been "ENTER BASE YEAR AND COST INDEX (1979 = 100) (2)" as shown in Figure 4-4. This is the first question of the power plant module input routine.

The power plant cycle design routine requests the design input parameters in the order shown on the data record sheet shown in Figure 4-2. The values requested will only be the ones listed under the correct cycle type. After all the data values have been entered the cycle design routine and allows the user to correct any errors made during data entry.

The power plant module requires data not related to the cycle design parameters. This portion of the module accepts the values which determine the overall financial structure of the power plant design, shown in Figure 4-4. The data requests made by this module correspond to the data record sheet for the power plant design shown in Figure 4-5. After all data values have been entered the module enters the power plant change routine and allows the user to correct any errors made during data entry.

4.2.2 Existing Power Plant

When the keyword name entered already exists the model gives the user several options. The user may elect to delete the

WELCOME TO THE GEOTHERMAL LOAN GUARANTY CASH FLOW MODEL.
MODULES AVAILABLE

- 1 = POWER PLANT DESIGN MODULE
- 2 = FIELD DESIGN MODULE
- 3 = FINANCIAL MODULE

ENTER NUMBER OF MODULE DESIRED?

?

1

CURRENT POWER PLANT NAMES:

HEBER
ERAW
GELCCM
IMPERIAL-X
550B1 REPUN
MARK
BINARY
GEYSER
TPC-GEYSER

ENTER POWER PLANT NAME (UP TO 20 CHARACTERS).

SAMPLE

NO POWER PLANT EXISTS UNDER THAT NAME.

IS A NEW POWER PLANT TO BE CREATED? (Y OR N)

Y

INPUT POWER PLANT TYPE

- 1 = DRY STFAM
- 2 = SINGLE STAGE FLASH
- 3 = DUAL STAGE FLASH
- 4 = BRINE/BINARY

?

4

DO YOU WISH TO USE THE POWER PLANT CYCLE DESIGN ROUTINE? (Y OR N).

Y

SAMPLE
BINARY

1 TEMPERATURE OF UNFLASHED FLUID (DEG.F.)?

?

450

2 PRESSURE OF UNFLASHED FLUID (PSI)?

?

430

3 REINJECTION TEMPERATURE (DEG.F.)?

?

234

FIGURE 4-3
EXECUTION OF NEW CYCLE DESIGN ROUTINE

4 REINJECTION PRESSURE (PSI)?
 ?
 370
 5 DISSOLVED SOLIDS (PPM)?
 ?
 0
 6 PLANT NET SALES OUTPUT (MW)?
 ?
 50
 7 GENERATOR EFFICIENCY (%)?
 ?
 98
 8 TURBINE EFFICIENCY (%)?
 ?
 85
 9 W. F. TEMPERATURE-TURBINE INLET (DEG.F.)?
 ?
 373
 10 W. F. PRESSURE-TURBINE INLET (PSI)?
 ?
 1600
 11 W. F. PRESSURE-TURBINE OUTLET (PSI)?
 ?
 70
 12 COOLING WATER TEMPEFATURE-COND. INLET?
 ?
 90
 13 COOLING WATER TEMPERATURE-COND. OUTLET?
 ?
 101
 14 DESIGN WET BULB TEMP (DEG.F.)?
 ?
 80
 15 HEIGHT OF COOLING TOWER (FI.).....?
 ?
 40
 16 PUMP AND PIPING MATERIAL (1=CS,2=SS)?

?
 2
FIGURE 4-3
EXECUTION OF NEW CYCLE DESIGN ROUTINE
(CONTINUED)

?
1
17 PUMP DRIVER TYPES (1=MOTOR,2=TURBINE)?

?
1
18 COOLING TOWER TYPE (1=WET,2=DRY)?

?
1
19 COOLING TOWER MATERIAL (1=WOOD,2=CONCRETE)?

?
1
DATA INPUT COMPLETED.
VERIFY DATA
SAMPLE
BINARY

NUMBER	PARAMETER	CURRENT VALUE
1	TEMPERATURE OF UNFLASHED FLUID (DEG.F.)	450.00000
2	PRESSURE OF UNFLASHED FLUID (PSI)	430.00000
3	REINJECTION TEMPERATURE (DEG.F.)	234.00000
4	REINJECTION PRESSURE (PSI)	370.00000
5	DISOLVED SOLIDS (PPM)	0.0
6	PLANT NET SALES OUTPUT (MW)	50.00000
7	GENERATOR EFFICIENCY (%)	98.00000
8	TURBINE EFFICIENCY (%)	85.00000
9	W. F. TEMPERATURE-TURBINE INLET (DEG.F.)	373.00000
10	W. F. PRESSURE-TURBINE INLET (PSI)	1600.00000
11	W. F. PRESSURE-TURBINE OUTLET (PSI)	70.00000
12	COOLING WATER TEMPERATURE-CONC. INLET	90.00000
13	COOLING WATER TEMPERATURE-CONC. OUTLET	101.00000
14	DESIGN WET BULB TEMP (DEG.F.)	80.00000
15	HEIGHT OF COOLING TOWER (FT.)	40.00000
16	PUMP AND PIPING MATERIAL (1=CS,2=SS)	2
17	PUMP DRIVER TYPES (1=MOTOR,2=TURBINE)	1
18	COOLING TOWER TYPE (1=WET,2=DRY)	1
19	COOLING TOWER MATERIAL (1=WOOD,2=CONCRETE)	1

ENTER VARIABLE NUMBER AND THE NEW VALUE.
A ZERO OR NULL RETURN WILL TERMINATE THE CHANGE ROUTINE.

?

*

ENTER BASE YEAR AND COST INDEX (1979=100). (2)
DEFAULT - BASE YEAR = 1979

FIGURE 4-3
EXECUTION OF NEW CYCLE DESIGN ROUTINE
(CONCLUDED)

B

WELCOME TO THE GEOTHERMAL LOAN GUARANTY CASH FLOW MODEL.
MODULES AVAILABLE

1 = POWER PLANT DESIGN MODULE

2 = FIELD DESIGN MODULE

3 = FINANCIAL MODULE

ENTER NUMBER OF MODULE DESIRED?

?

1

CURRENT POWER PLANT NAMES:

HEBER

BRAW

GELCOM

IMPERIAL-X

550B1 RERUN

MARK

BINARY

GEYSER

TPC-GEYSER

ENTER POWER PLANT NAME (UP TO 20 CHARACTERS).

sample

NO POWER PLANT EXISTS UNDER THAT NAME.

IS A NEW POWER PLANT TO BE CREATED? (Y OR N)

Y

INPUT POWER PLANT TYPE

1 = DRY STEAM

2 = SINGLE STAGE FLASH

3 = DUAL STAGE FLASH

4 = BRINE/BINARY

?

4

DO YOU WISH TO USE THE POWER PLANT CYCLE DESIGN ROUTINE? (Y OR N).

N

ENTER BASE YEAR AND COST INDEX (1979=100). (2)

DEFAULT - BASE YEAR = 1979

- COST INDEX = 100.0

?

1980 115.0

ENTER PROJECT LIFE AND POWER-ON-LINE YEAR. (2)

*** NO DEFAULTS ***

?

12 1982

POWER PLANT CYCLE DESIGN ROUTINE NOT USED.

ENTER POWER PLANT SALES OUTPUT. (MWE)

?

50.0

POWER PLANT CYCLE DESIGN ROUTINE NOT USED.

ENTER POWER PLANT TURBINE RATING. (MWE)

FIGURE 4-4
CREATION OF NEW POWER PLANT DESIGN

?
68.8
POWER PLANT CYCLE DESIGN ROUTINE NOT USED.
ENTER POWER PLANT BRINE REQUIREMENT. (K LB/HB)

?
4692.5
POWER PLANT CYCLE DESIGN ROUTINE NOT USED.
ENTER POWER PLANT CAPITAL COSTS (5 ACCOUNTS). (\$000)

?
10000 7000 4000 6000 11000
ENTER BOOK LIFE AND TAX LIFE OF CAPITAL ACCOUNT #1. (2)
DEFAULT - BOOK = 20
- TAX = 20

?
10 10
ENTER SALVAGE AND O & M FRACTIONS FOR
CAPITAL ACCOUNT #1. (2)

?
0 .05
ENTER BOOK LIFE AND TAX LIFE OF CAPITAL ACCOUNT #2. (2)
DEFAULT - BOOK = 5
- TAX = 5

?
ENTER SALVAGE AND O & M FRACTIONS FOR
CAPITAL ACCOUNT #2. (2)

?
0 .10
ENTER BOOK LIFE AND TAX LIFE OF CAPITAL ACCOUNT #3. (2)
DEFAULT - BOOK = 12
- TAX = 12

?
5 5
ENTER SALVAGE AND O & M FRACTIONS FOR
CAPITAL ACCOUNT #3. (2)

?
0 .05
ENTER BOOK LIFE AND TAX LIFE OF CAPITAL ACCOUNT #4. (2)
DEFAULT - BOOK = 30
- TAX = 30

?
10 10
ENTER SALVAGE AND O & M FRACTIONS FOR
CAPITAL ACCOUNT #4. (2)

?
0 .05
ENTER BOOK LIFE AND TAX LIFE OF CAPITAL ACCOUNT #5. (2)

FIGURE 4-4
CREATION OF NEW POWER PLANT DESIGN
(CONTINUED)

DEFAULT - BOOK = 30
- TAX = 30

?

10 5

ENTER SALVAGE AND O & M FRACTIONS FOR
CAPITAL ACCOUNT #5. (2)

?

OTHER OPERATING COSTS -
DEFAULTS = 0.0

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

?

100 0 3 12

?

VALUES FOR YEARS 1 TO 12:

0.0	0.0	100.000	100.000	100.000
100.000	100.000	100.000	100.000	100.000
100.000	100.000			

ENTER SUNK COSTS (\$000).

DEFAULT = 0.0

?

4000

ENTER 2 ANNUAL INVESTMENT FRACTIONS FOR CONSTRUCTION PERIOD.

DEFAULT VALUES -

YEAR - 1 0.400

2 0.600

?

.25 .75

POWER PLANT DESIGN DATA CHANGE ROUTINE - PARAMETER MENU

POWER PLANT NAME--SAMPLE

1 BASE YEAR	(1)	9 BOOK LIVES-PLANT CAP.	(5)
2 PLANT COST INDEX	(1)	10 TAX LIVES -PLANT CAP.	(5)
3 PROJECT LIFE	(1)	11 SALV RATES-PLANT CAP.	(5)
4 POWER-ON-LINE YEAR	(1)	12 OEM RATES -PLANT CAP.	(5)
5 P.P. NET SALES OUTPUT	(1)	13 OTHER OPERATING COSTS	(50)
6 P.P. TURBINE RATING	(1)	14 SUNK COSTS	(1)
7 BRINE FLOW REQUIRED	(1)	15 CAPITAL INV. SPREAD	(1-9)
8 PLANT CAPITAL COSTS	(5)		

ENTER VARIABLE NUMBER.

A ZERO OR NULL RETURN WILL TERMINATE THE CHANGE ROUTINE.

?

GLGP CASH FLOW MODEL

POWER PLANT DESIGN & CAPITAL COST REPORT

POWER PLANT NAME	-SAMPLE
POWER PLANT CYCLE TYPE	-BRINE BINARY
PLANT NET OUTPUT (MWE)	- 50.0
BASE YEAR	- 1980
POWER-ON-LINE YEAR	- 1982
PROJECT LIFE	- 12
COST INDEX (1979=100.0)	-115.0

FIGURE 4-4
CREATION OF NEW POWER PLANT DESIGN
(CONTINUED)

	TOTAL	
	COST (K\$)	
CAPITAL CATEGORY #1	10000.0	
CAPITAL CATEGORY #2	7000.0	
CAPITAL CATEGORY #3	4000.0	
CAPITAL CATEGORY #4	6000.0	
CAPITAL CATEGORY #5	11000.0	
CAPITAL COST OF POWER PLANT COMPONENTS (K\$)		38000.0
SUNK COSTS (K\$)		4000.0
TOTAL CAPITAL COST OF POWER PLANT (K\$)		42000.0
TOTAL BRINE FLOW REQUIRED BY THE PLANT (K LB/HR)		4692.5
POWER PLANT GROSS OUTPUT (MWE).		68.8

DO YOU WISH TO PERFORM FINANCIAL CALCULATIONS
 BASED ON THE-SAMPLE
 POWER PLANT DESIGN?
 (Y OR N)

ENTER POWER PLANT NAME (UP TO 20 CHARACTERS).

WELCOME TO THE GEOTHERMAL LOAN GUARANTY CASH FLOW MODEL.
 MODULES AVAILABLE
 1 = POWER PLANT DESIGN MODULE
 2 = FIELD DESIGN MODULE
 3 = FINANCIAL MODULE
 ENTER NUMBER OF MODULE DESIRED?

?

THANK YOU FOR USING GCFM

R: T=5.25/11.30 15:06:06
 sp con sto close

FIGURE 4-4
 CREATION OF NEW POWER PLANT DESIGN
 (CONCLUDED)

GLCP Cash Flow Model
Data Record Sheet - POWER PLANT DESIGN

CASE NAME: Sample

RUN DATE: _____ RUN TIME: _____ RUN NUMBER: _____

GENERAL DATA				DEFAULT	
1	Base Year	1980		1979	
2	Plant Cost Index	116.0		100.0	
3	Project Life	12			
4	Power-on-Line Year	1982			
5	Net Sales Output (MWE)	50.0		0.0	
6	Turbine Rating (MWE)	68.8		Calculated	
7	Brine Flow Req. (KLB/HR)	4692.5		Calculated	
	8 - Capital	9 - Book		10 - Tax	
CAPITAL ACCOUNTS		Cost* (K\$)	Life**	Life***	
#1		10,000	10	10	
#2		7,000	5	5	
#3		4,000	5	5	
#4		6,000	10	10	
#5		11,000	10	5	
	11 - Salvage	12 - O&M			
CAPITAL ACCOUNTS		Rate****	Rate****		
#1		0	0.05		
#2		0	0.10		
#3		0	0.05		
#4		0	0.05		
#5		0	0.00		
	Range #	Value	Rate	FY	LY
13	Other #1	0	0	1	2
	Operating #2	100	0	3	4
	Costs (K\$) #3				
14	Sunk Costs (K\$)	4000			0.0
15	Construction	#1 0.25	#2 0.75	#3	Calculated
	Investment	#4	#5	#6	
	Breakdown	#7	#8	#9	

- * Capital Cost Defaults Calculated
 ** Book Life Defaults - 20/5/12/30/30
 *** Tax Life Defaults - 20/5/12/30/30
 **** Salvage Rates and O-M Rates Default to zero

FIGURE 4-5
POWER PLANT DESIGN

power plant design, use the cycle design routine changing data values, change power plant design parameters or even execute the module changing nothing. Figure 4-6 is an example of executing the power plant routine while changing nothing. This Figure also shows the design summary report which is sent to the users terminal after execution of the power plant module. At this point the user may elect to enter the financial module to delete, change or create financial cases, or perform financial analysis on this power plant design.

4.3 Field Module

4.3.1 New Field Design

The field module does not have a distinct "design" routine as does the power plant module. The field module prompts the user both for design parameters, such as resource characteristics and for values which determine the overall financial structure of the field design shown in Figure 4-7. The data requests made by this module correspond to the data record sheet for the field design shown in Figure 4-8. After all data values have been entered the module enters the field change routine and allows the user to correct any errors made during data entry.

4.3.2 Existing Field Design

When the keyword name entered already exists the model gives the user several options. The user may elect to delete or to execute without changing the field project. Figure 4-9 shows the execution of the Field Module when an existing field design is used without

B

WELCOME TO THE GEOTHERMAL LOAN GUARANTY CASH FLOW MODEL.
MODULES AVAILABLE
1 = POWER PLANT DESIGN MODULE
2 = FIELD DESIGN MODULE
3 = FINANCIAL MODULE
ENTER NUMBER OF MODULE DESIRED?

?

1

CURRENT POWER PLANT NAMES:

HEBER
ERAW
GELCOM
IMPERIAL-X
SSOE1 RERUN
HARK
BINARY
SAMPLE
GEYSER
TPC-GEYSER

ENTER POWER PLANT NAME (UP TO 20 CHARACTERS).

sample

A POWER PLANT ALREADY EXISTS UNDER THAT NAME.

DO YOU WISH TO DELETE IT? (Y OR N).

n

DO YOU WISH TO USE THE POWER PLANT CYCLE DESIGN
PROGRAM? (Y OR N).

n

DO YOU WISH TO CHANGE ANY POWER PLANT DESIGN PARAMETERS ? (Y OR N)

n

GLGP CASH FLOW MODEL

POWER PLANT DESIGN & CAPITAL COST REPORT

POWER PLANT NAME	-SAMPLE
POWER PLANT CYCLE TYPE	-BRINE BINARY
PLANT NET OUTPUT (MW)	- 50.0
BASE YEAR	- 1980
POWER-ON-LINE YEAR	- 1982
PROJECT LIFE	- 12
COST INDEX (1979=100.0)	-115.0

	TOTAL COST(K\$)
CAPITAL CATEGORY #1	10000.0
CAPITAL CATEGORY #2	7000.0
CAPITAL CATEGORY #3	4000.0
CAPITAL CATEGORY #4	6000.0
CAPITAL CATEGORY #5	11000.0

CAPITAL COST OF POWER PLANT COMPONENTS (K\$)	38000.0
SUNK COSTS (K\$)	4000.0
TOTAL CAPITAL COST OF POWER PLANT (K\$)	42000.0

TOTAL BRINE FLOW REQUIRED BY THE PLANT (K LB/HR)	4692.5
--	--------

POWER PLANT GROSS OUTPUT (MW).	68.8
--------------------------------	------

DO YOU WISH TO PERFORM FINANCIAL CALCULATIONS
BASED ON THE-SAMPLE
POWER PLANT DESIGN?
(Y OR N)

n

ENTER POWER PLANT NAME (UP TO 20 CHARACTERS).

SP CON STO CLOSE

FIGURE 4-6
USE OF AN EXISTING POWER PLANT DESIGN

WELCOME TO THE GEOTHERMAL LOAN GUARANTY CASH FLOW MODEL.
MODULES AVAILABLE

1 = POWER PLANT DESIGN MODULE
2 = FIELD DESIGN MODULE
3 = FINANCIAL MODULE
ENTER NUMBER OF MODULE DESIRED?

?

2

CURRENT FIELD NAMES:

IMEPIAL-X
TEST/V3.0
BASELINE
DEMO
T1
MARK
PRAW
FTEST
TESTOR

ENTER FIELD NAME (UP TO 20 CHARACTERS).

sample

NO FIELD EXISTS UNDER THAT NAME.

IS A NEW FIELD TO BE CREATED? (Y OR N)

Y

ENTER BASE YEAR AND COST INDEX (1979=100). (2)
DEFAULT - BASE YEAR = 1979
- COST INDEX = 100.0

?

1980 115.0

ENTER PROJECT LIFE AND POWER-ON-LINE YEAR. (2)
*** NO DEFAULTS ***

?

12 1982

ENTER POWER PLANT TYPE. (1=STEAM,2=BINARY)
DEFAULT = 1/STEAM

?

2

ENTER FIELD OUTPUT. (MWE)
*** NO DEFAULT ***

?

50

ENTER FIELD ELECTRIC POWER CONSUMPTION. (MWE)
DEFAULT - CALCULATED

?

0.0

ENTER BRINE FLOW REQUIRED BY POWER PLANT. (K LB/HR)
*** NO DEFAULT ***

FIGURE 4-7 CREATION OF NEW FIELD DESIGN

?
4692.5
ENTER WELL DEPTH. (FFET)
*** NO DEFAULT ***

?
5000
ENTER DISSOLVED SOLID CONTENT OF BRINE. (PPM)
DEFAULT = 0.0

?
0.0
ENTER ROCK HARDNESS - 1 = SOFT
 - 2 = MEDIUM
 - 3 = HARD

DEFAULT = 1/SOFT

?
2
ENTER RESOURCE TEMPERATURE. (DEG. F.)
*** NO DEFAULT ***

?
450
ENTER WELL PRODUCTION RATE (K LB/HR) AND INJECTION RATE (K LB/HR). (2)
DEFAULTS - CALCULATED

?

ENTER COST PER PRODUCTION AND INJECTION WELL (\$000). (2)
DEFAULT - CALCULATED

?

ENTER CCST PER DOWN HOLE PUMP. (K\$)
DEFAULT = 250.0

?

ENTER DOWN HOLE PUMP USAGE SWITCH.
1 = NO DOWN HOLE PUMPS USED.
2 = DOWN HOLE PUMPS USAGE DETERMINED BY DFSIGN ROUTINE. (DEFAULT)
3 = DOWN WELL PUMPS USED.

?
2
ENTER BOOK LIFE AND TAX LIFE OF PRODUCTION WELLS. (2)
DEFAULTS - BOOK = 10
 - TAX = 6

?

ENTER SALVAGE AND O & M FRACTIONS FOR PRODUCTION WELLS. (2)

**FIGURE 4-7
CREATION OF NEW FIELD DESIGN
(CONTINUED)**

?
0 .1
ENTER BOOK LIFE AND TAX LIFE OF INJECTION WELLS. (2)
DEFAULTS - BOOK = 10
- TAX = 6

?
ENTER SALVAGE AND O & M FRACTIONS FOR INJECTION WELLS. (2)

?
0 .1
ENTER BOOK LIFE AND TAX LIFE OF DOWN HOLE PUMPS. (2)
DEFAULTS - BOOK = 5
- TAX = 5

?
10 10
ENTER SALVAGE AND O & M FRACTIONS FOR DOWN HOLE PUMPS. (2)

?
0 .40
ENTER IDC RATES FOR PRODUCTION AND INJECTION WELLS. (2)
DEFAULTS = 0.0

?
.75 .75
WELL DRILLING SUCCESS RATIO -
DEFAULTS = 1.0

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

?
.8 0 1 2 .75 0 3 12

?
?

VALUES FOR YEARS 1 TO 12:

0.800	0.800	0.750	0.750	0.750
0.750	0.750	0.750	0.750	0.750
0.750	0.750			

NUMBER OF MAKE-UP WELLS -
DEFAULTS = 0.0

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

?
1 0 5 5
?
1 0 7 7
?
1 0 9 9
?

VALUES FOR YEARS 1 TO 12:

0.0	0.0	0.0	0.0	1.000
0.0	1.000	0.0	1.000	0.0
0.0	0.0			

COST PER MAKE-UP WELL -
DEFAULTS = 0.0

FIGURE 4-7
CREATION OF NEW FIELD DESIGN
(CONTINUED)

1000
?
ENTER COST OF FIELD CAPITAL ACCOUNT #4
DEFAULT AVAILABLE

?
ENTER BOOK LIFE AND TAX LIFE OF CAPITAL ACCOUNT #4
DEFAULTS - BOOK = 20
 - TAX = 20

?
10 10
ENTER SALVAGE AND O & M FRACTIONS
FOR CAPITAL ACCOUNT #4

?
0 0
ENTER COST OF FIELD CAPITAL ACCOUNT #5
DEFAULT AVAILABLE

?
ENTER BOOK LIFE AND TAX LIFE OF CAPITAL ACCOUNT #5
DEFAULTS - BOOK = 30
 - TAX = 12

?
10 5
ENTER SALVAGE AND O & M FRACTIONS
FOR CAPITAL ACCOUNT #5

?
ENTER TOTAL FIELD EXPLORATION COSTS. (\$000)
DEFAULT = 0.0

?
3000
OTHER OPERATING COSTS -
DEFAULTS = 0.0

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

?
100 0 1 12
?
0 0 1 2
?

VALUES FOR YEARS 1 TO 12:

0.0	0.0	100.000	100.000	100.000
100.000	100.000	100.000	100.000	100.000
100.000	100.000			

ENTER SUNK COSTS. (\$000)
DEFAULT = 0.0

FIGURE 4-7
CREATION OF NEW FIELD DESIGN
(CONTINUED)

?
4000

ENTER 2 ANNUAL INVESTMENT FRACTIONS FOR CONSTRUCTION PERIOD.

DEFAULT VALUES -

YEAR - 1 0.400
2 0.600

?

.55 .45

FIELD DESIGN DATA CHANGE ROUTINE - PARAMETER MENU

FIELD CASE NAME--SAMPLE

1 BASE YEAR	(1)	18 TAX LIVES -WELLS	(3)
2 PLANT COST INDEX	(1)	19 SALVAGE RATE-WELLS	(3)
3 PROJECT LIFE	(1)	20 O & M RATE -WELLS	(3)
4 POWER-ON-LINE YEAR	(1)	21 INTAN. DRILLING CST RTS	(2)
5 PLANT TYPE	(1)	22 DRILLING SUCCESS RATIO	(50)
6 FIELD OUTPUT	(1)	23 COST PER MAKEUP WELL	(1)
7 FIELD ELEC. CONS.	(1)	24 NUMBER OF MAKE-UP WELLS	(50)
8 BRINE FLOW REQUIRED	(1)	25 FIELD PLANT CAP. COSTS	(2)
9 DEPTH	(1)	26 BOOK LIVES-FIELD CAP.	(2)
10 SALINITY	(1)	27 TAX LIVES -FIELD CAP.	(2)
11 ROCK HARDNESS	(1)	28 SALVAGE RATE-FIELD CAP.	(2)
12 TEMPERATURE	(1)	29 O & M RATE -FIELD CAP.	(2)
13 WELL FLOW RATES	(2)	30 FIELD EXPLORATION COSTS	(1)
14 TOTAL COSTS OF WELLS	(2)	31 OTHER OPERATING COSTS	(50)
15 TOTAL COST-DOWNHOLE PUMP	(1)	32 SUNK COSTS	(1)
16 DOWN HOLE PUMP SWITCH	(1)	33 CAPITAL INV. SPREAD	(1-9)
17 BOOK LIVES -WELLS	(3)		

ENTER VARIABLE NUMBER.

A ZERO OR NULL RETURN WILL TERMINATE THE CHANGE ROUTINE.

?

GIGP CASH FLOW MODEL

FIELD DESIGN & CAPITAL COST REPORT

FIELD NAME -SAMPLE
POWER PLANT TYPE -BINARY
FIELD SIZE (MWE GROSS) - 50.0
BASE YEAR - 1980
POWER-ON-LINE YEAR - 1982
PROJECT LIFE - 12
COST INDEX (1979=100.0) -115.0

RESERVOIR INPUT DATA:

RESOURCE TEMPERATURE (DEG.F)	450.0
WELL DEPTH (FEET)	5000.0
DISSOLVED SOLIDS (PPM)	0.0
ROCK TYPE	MEDIUM

BRINE FLOW RATES:

BRINE FLOW FROM FIELD (K LB/HR)	4692.5
PRODUCTION WELL FLOW (K LB/HR)	600.0
REINJECTION WELL FLOW (K LB/HR)	2436.4

FIGURE 4-7
CREATION OF NEW FIELD DESIGN
(CONTINUED)

TOTAL COST OF WELLS (\$000)	8004.0
COST OF DOWN HOLE PUMPS (\$000)	2000.0
FIELD EQUIPMENT COSTS (\$000)	5220.0
FIELD EXPLORATION COSTS (\$000)	3000.0
CAPITALIZED DRY HOLE EXPENSES (\$000)	1656.0
TOTAL CAPITAL COST (\$000)	19880.0
SUNK COSTS (\$000)	4000.0
CAPITAL COSTS (INCLUDING SUNK COSTS)	23880.0
FIELD ELECTRICITY CONSUMPTION (MWE)	0.0

-COSTS PER PRODUCTION AND INJECTION WELLS HAVE
BEEN CALCULATED BY THE DESIGN PROGRAM.

-FIELD CAPITAL COSTS HAVE BEEN CALCULATED BY THE DESIGN PROGRAM.

-FLOW RATES HAVE BEEN CALCULATED BY THE DESIGN PROGRAM.
-DOWN HOLE PUMPS ARE BEING USED IN THIS CASE.

DO YOU WISH TO PERFORM FINANCIAL CALCULATIONS
BASED ON THE-SAMPLE
FIELD DESIGN? (Y OR N)

ENTER FIELD NAME (UP TO 20 CHARACTERS).

FIGURE 4-7
CREATION OF NEW FIELD DESIGN
(CONCLUDED)

GLGP Cash Flow Model
Data Record Sheet - FIELD DESIGN (Sheet 1 of 2)

CASE NAME: Sample

RUN DATE: _____ RUN TIME: _____ RUN NUMBER: _____

GENERAL DATA					DEFAULT
1	Base Year	1980			1979
2	Plant Cost Index	115.0			100.0
3	Project Life	12			_____
4	Power-On-Line Year	1982			_____
5	Plant Type	2			1 (Steam)
6	Field Output (MWE)	50.0			0.0
7	Field Elect. Con. (MWE)	0.0			Calculated
8	Brine Flow Req. (KLB/HR)	4692.5			
RESERVOIR DATA					
9	Depth (FT)*	5000			0.0
10	Salinity (PPM)*	0.			0.0
11	Rock Type (1,2,3)*	2			1 (Soft)
12	Temperature (F°)*	450.			0.0
WELL DATA		PROD**	INJ**	DPW**	
13	Well Flow Rates (KLB/HR)	0.0	0.0		Calculated
14	Cost of Wells*** (K\$)	0.0	0.0		Calculated
15	Cost Per DWP** (K\$)			0.0	250
16	DWP Switch (1,2,3)			2	2
17	Book Lives	10	10	10	10/10/5
18	Tax Lives	6	6	10	6/6/5
19	Salvage Rates	0.		0.	0.0
20	O&M Rates	0.10	0.10	0.40	0.0
21	IDC Rates****	0.75	0.75		0.0

- * Values may be required for calculated default values
 ** PROD - Production Wells, INJ - Injection Wells and DWP - Downwell Pumps
 *** Input Routine - Enter Cost Per Well
 Change Routine - Enter Total Cost of Wells
 **** IDC - Intangible Drilling Costs

FIGURE 4-8
FIELD DESIGN INPUT SHEET

GLGP Cash Flow Model
Data Record Sheet - FIELD DESIGN (Sheet 2 of 2)

CASE NAME: Sample

RUN DATE: _____ RUN TIME: _____ RUN NUMBER: _____

WELL DATA (continued)					DEFAULT	
	Range #	Value	Rate	FY	LY	
22 Drilling	#1	.8	0	1	2	1.0 for all years
Success Ratio	#2	.75	0	3	12	
	#3					
23 Cost per Makeup Well						0.0
	Range #	Value	Rate	FY	LY	
24 Number of Makeup	#1	0	0	1	12	0.0 for all years
Wells	#2					
	#3					
FIELD PLANT DATA		ACCT. #4	ACCT. #5			DEFAULT
25 Field Plant Cap. (K\$)		0.0	0.0			Calculated
26 Book Lives		10	10			20/30
27 Tax Lives		10	5			20/12
28 Salvage Rates		0.0	0.0			0.0
29 O&M Rates		0.0	0.0			0.0
OTHER DATA						
30 Field Exploration Cost		3000				0.0
	Range #	Value	Rate	FY	LY	
31 Other Operating	#1	0	0	1	12	0.0 for all years
Costs (K\$)	#2	100	0	3	12	
	#3					
32 Sunk Costs (K\$)		4000				0.0
33 Construction	#1	0.55	#2	0.45	#3	Calculated
Investment	#4		#5		#6	
Breakdown	#7		#8		#9	

FIGURE 4-8
FIELD DESIGN INPUT SHEET
(CONCLUDED)

ENTER POWER PLANT NAME (UP TO 20 CHARACTERS).

WELCOME TO THE GEOTHERMAL LOAN GUARANTY CASH FLOW MODEL.

MODULES AVAILABLE

1 = POWER PLANT DESIGN MODULE

2 = FIELD DESIGN MODULE

3 = FINANCIAL MODULE

ENTER NUMBER OF MODULE DESIRED?

?

2

CURRENT FIELD NAMES:

INEFIAL-X

TEST/V3.0

BASLINE

DEMO

SAMPLE

T1

MARK

ERAW

FTEST

TESTOR

ENTER FIELD NAME (UP TO 20 CHARACTERS).

sample

A FIELD ALREADY EXISTS UNDER THAT NAME.

DO YOU WISH TO DELETE IT? (Y OR N)

n

DO YOU WISH TO CHANGE ANY FIELD DESIGN PARAMETERS? (Y OR N)

n

GLGP CASH FLOW MODEL

FIELD DESIGN & CAPITAL COST REPORT

FIELD NAME	-SAMPLE
POWER PLANT TYPE	-BINARY
FIELD SIZE (MWE GRCSS)	- 50.0
BASE YEAR	- 1980
POWER-ON-LINE YEAR	- 1982
PROJECT LIFE	- 12
COST INDEX (1979=100.0)	-115.0

RESERVOIR INPUT DATA:

RESOURCE TEMPERATURE (DEG.F)	450.0
WELL DEPTH (FEET)	5000.0
DISOLVED SOLIDS (PPM)	0.0
ROCK TYPE	MEDIUM

BRINE FLOW RATES:

BRINE FLOW FROM FIELD (K LB/HR)	4692.5
PRODUCTION WELL FLOW (K LB/HR)	600.0
REINJECTION WELL FLOW (K LB/HR)	2436.4

TOTAL COST OF WELLS (\$000)	8004.0
-----------------------------	--------

FIGURE 4-9
USE OF AN EXISTING FIELD DESIGN ROUTINE

COST OF DOWN HOLE PUMPS (\$000)	2000.0
FIELD EQUIPMENT COSTS (\$000)	5220.0
FIELD EXPLORATION COSTS (\$000)	3000.0
CAPITALIZED DRY HOLE EXPENSES (\$000)	1656.0
TOTAL CAPITAL COST (\$000)	19880.0
SUNK COSTS (\$000)	4000.0
CAPITAL COSTS (INCLUDING SUNK COSTS)	23880.0
FIELD ELECTRICITY CONSUMPTION (MWE)	0.0

-COSTS PER PRODUCTION AND INJECTION WELLS HAVE BEEN CALCULATED BY THE DESIGN PROGRAM.

-FIELD CAPITAL COSTS HAVE BEEN CALCULATED BY THE DESIGN PROGRAM.

-FLOW RATES HAVE BEEN CALCULATED BY THE DESIGN PROGRAM.

-DOWN HOLE PUMPS ARE BEING USED IN THIS CASE.

FIGURE 4-9
USE OF AN EXISTING FIELD DESIGN ROUTINE
(CONCLUDED)

changes. The design summary report, also shown, is displayed for the user at the terminal. At this point the user may elect to enter the financial module to delete, change or create financial cases and/or perform financial analysis on this field design.

4.4 Financial Module

The financial module is intended to be used in conjunction with either the power plant module or the field module. The module provides facilities for creation, deletion and change of financial cases. However, without prior execution of either of the costing modules, the financial module analysis capabilities will not function.

4.4.1 New Financial Case

A financial case is a collection of financial parameters needed for life cycle costing analysis. The financial module prompts the user for parameters which describes the economic conditions under which the project will operate. This is shown in Figure 4-10. The data request made by this module correspond to the data record sheet for the financial case shown in Figure 4-11. After all data values have been entered the module enters the financial change routine and allows the user to correct any errors made during data entry.

4.4.2 Existing Financial Case

When the keyword entered already exists the model gives the user several options. The user may elect to delete the financial case, change the financial parameters, or execute the financial analysis portion of the financial module with or without making changes.

DO YOU WISH TO PERFORM FINANCIAL CALCULATIONS
BASED ON THE-SAMPLE
FIELD DESIGN? (Y OR N)

Y

CURRENT FINANCIAL CASE NAMES:

BASLINE

DEMO

KEN

TEST1

GELCCM

NEW

MARK

BRAW

TESTOR

GEYSER

TPC-GEYSER

IMPERIAL-X

ENTER FINANCIAL CASE NAME (UP TO 20 CHARACTERS) .

sample

NO FINANCIAL CASE EXISTS UNDER THAT NAME.

IS A NEW FINANCIAL CASE TO BE CREATED? (Y OR N)

Y

DO YOU WISH TO INITIALIZE THE FINANCIAL CASE - SAMPLE
WITH THE DATA CONTAINED IN THE "BASELINE" FINANCIAL CASE AND
PROCEED DIRECTLY TO THE PARAMETER CHANGE ROUTINE? (Y OR N) .

n

ENTER FINANCIAL BASE YEAR AND POWER-ON-LINE YEAR. (2)

DEFAULT - BASE YEAR = 1979

*** NO DEFAULT FOR POWER-ON-LINE YEAR. ***

?

1980 1982

FIGURE 4-10
CREATION OF A FINANCIAL MODULE

ENTER PROJECT LIFE AND LOAN LIFE. (2)
*** NO DEFAULTS ***

?

12 10

ENTER WORKING CAPITAL BASE VALUE. (\$000)
DEFAULT = 0.0

?

4000

ENTER ELECTRICITY PRICE AND GEOTHERMAL FLUID PRICE (MILLS/KW). (2)
DEFAULT - ELECTRICITY MARKET PRICE = 50.0
- FLUID MARKET PRICE = 20.0

?

140 70

ANNUAL CAPACITY FACTORS-
** WARNING--FACTORS FOR CONSTRUCTION YEARS MUST BE ZERO
DEFAULTS- CONST = 0.0
- OPERTNS = 0.8

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

?

.5 0 3 4

?

.9 0 4 12

?

VALUES FOR YEARS 1 TO 12:

0.0	0.0	0.500	0.900	0.900
0.900	0.900	0.900	0.900	0.900
0.900	0.900			

ENTER MINIMUM EQUITY FRACTION.
DEFAULT = 0.25

?

.25

ENTER MINIMUM ANNUAL EQUITY FRACTIONS. (2)
DEFAULTS = 0.0

?

.10 .10

EQUITY RATES OF RETURN -
DEFAULTS = 0.0

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

?

.30 0 3 12

?

VALUES FOR YEARS 1 TO 12:

0.0	0.0	0.300	0.300	0.300
0.300	0.300	0.300	0.300	0.300
0.300	0.300			

PAYMENTS ON DEBT (ZERO PAYMENTS DURING CONSTRUCTION YEARS)-
DEFAULTS TO EQUAL PRINCIPAL PAYMENTS

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

FIGURE 4-10
CREATION OF A FINANCIAL MODULE
(CONTINUED)

?

VALUES FOR YEARS 1 TO 12:

0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0
0.0	0.0			

INTEREST RATES ON DEBT -
DEFAULTS = 0.0

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

?

.18 0 1 2

?

.15 0 3 12

?

VALUES FOR YEARS 1 TO 12:

0.180	0.180	0.150	0.150	0.150
0.150	0.150	0.150	0.150	0.150
0.150	0.150			

ENTER DOE FEE RATE.
DEFAULT = 0.01

?

SINKING FUND DEPOSITS -
DEFAULT CALCULATED BY FINANCIAL ROUTINE

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

?

VALUES FOR YEARS 1 TO 12:

0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0
0.0	0.0			

ENTER SINKING FUND INTEREST RATE.
DEFAULT = 0.0

?

.10

GENERAL INFLATION RATES -
DEFAULTS = 0.0

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

?

.12 0 1 12

?

VALUES FOR YEARS 1 TO 12:

0.120	0.120	0.120	0.120	0.120
0.120	0.120	0.120	0.120	0.120
0.120	0.120			

ESCALATION FACTORS FOR CAPITAL INVESTMENT -
DEFAULT = 0.0

INPUT UP TO 5 CATEGORY NUMBERS.

FIGURE 4-10
CREATION OF A FINANCIAL MODULE
(CONTINUED)

?
1 2
?

ENTER VALUE, RATE OF CHANGE, FIRST YEAR& LAST YEAR

?
.16 0 1 12
?

VALUES FOR YEARS 1 TO 12:
CATEGORY#1 CATEGORY#2 CATEGORY#3 CATEGORY#4 CATEGORY#5

1	0.160	0.160	0.0	0.0	0.0
2	0.160	0.160	0.0	0.0	0.0
3	0.160	0.160	0.0	0.0	0.0
4	0.160	0.160	0.0	0.0	0.0
5	0.160	0.160	0.0	0.0	0.0
6	0.160	0.160	0.0	0.0	0.0
7	0.160	0.160	0.0	0.0	0.0
8	0.160	0.160	0.0	0.0	0.0
9	0.160	0.160	0.0	0.0	0.0
10	0.160	0.160	0.0	0.0	0.0
11	0.160	0.160	0.0	0.0	0.0
12	0.160	0.160	0.0	0.0	0.0

INPUT UP TO 5 CATEGORY NUMBERS.

?
3 4
?

ENTER VALUE, RATE OF CHANGE, FIRST YEAR& LAST YEAR

?
.11 0 1 12
?

VALUES FOR YEARS 1 TO 12:
CATEGORY#1 CATEGORY#2 CATEGORY#3 CATEGORY#4 CATEGORY#5

1	0.160	0.160	0.110	0.110	0.0
2	0.160	0.160	0.110	0.110	0.0
3	0.160	0.160	0.110	0.110	0.0
4	0.160	0.160	0.110	0.110	0.0
5	0.160	0.160	0.110	0.110	0.0
6	0.160	0.160	0.110	0.110	0.0
7	0.160	0.160	0.110	0.110	0.0
8	0.160	0.160	0.110	0.110	0.0
9	0.160	0.160	0.110	0.110	0.0
10	0.160	0.160	0.110	0.110	0.0
11	0.160	0.160	0.110	0.110	0.0
12	0.160	0.160	0.110	0.110	0.0

INPUT UP TO 5 CATEGORY NUMBERS.

?

ESCALATION FACTORS FOR ELECTRICITY MARKET PRICE -
DEFAULTS = 0.0

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

?

**FIGURE 4-10
CREATION OF A FINANCIAL MODULE
(CONTINUED)**

.12 0 1 12
?

VALUES FOR YEARS 1 TO 12:

0.120	0.120	0.120	0.120	0.120
0.120	0.120	0.120	0.120	0.120
0.120	0.120			

ESCALATION FACTORS FOR FLUID MARKET PRICE -
DEFAULTS = 0.0

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

?
.14 0 1 12
?

VALUES FOR YEARS 1 TO 12:

0.140	0.140	0.140	0.140	0.140
0.140	0.140	0.140	0.140	0.140
0.140	0.140			

ESCALATION FACTORS FOR OPERATIONS & MAINTENANCE -
DEFAULTS = 0.0

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

?
.12 0 1 12
?

VALUES FOR YEARS 1 TO 12:

0.120	0.120	0.120	0.120	0.120
0.120	0.120	0.120	0.120	0.120
0.120	0.120			

ENTER ANNUAL CASH DISCOUNT RATES.
DEFAULTS = 0.0

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

?
.16 0 1 12
?

VALUES FOR YEARS 1 TO 12:

0.160	0.160	0.160	0.160	0.160
0.160	0.160	0.160	0.160	0.160
0.160	0.160			

PROPERTY TAX RATES -
DEFAULTS = 0.0

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

?
.02 0 1 12
?

VALUES FOR YEARS 1 TO 12:

0.020	0.020	0.020	0.020	0.020
0.020	0.020	0.020	0.020	0.020
0.020	0.020			

ROYALTY RATES -

FIGURE 4-10
CREATION OF A FINANCIAL MODULE
(CONTINUED)

DEFAULTS = 0.0

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

?
.05 0 1 12
?

VALUES FOR YEARS 1 TO 12:

0.050	0.050	0.050	0.050	0.050
0.050	0.050	0.050	0.050	0.050
0.050	0.050			

FEDERAL INCOME TAX RATES -
DEFAULTS = 0.0

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

?
.48 0 1 12
?

VALUES FOR YEARS 1 TO 12:

0.480	0.480	0.480	0.480	0.480
0.480	0.480	0.480	0.480	0.480
0.480	0.480			

STATE INCOME TAX RATES -
DEFAULTS = 0.0

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

?
.05 0 1 12
?

VALUES FOR YEARS 1 TO 12:

0.050	0.050	0.050	0.050	0.050
0.050	0.050	0.050	0.050	0.050
0.050	0.050			

INVESTMENT TAX CREDIT RATES -
DEFAULT = 0.0

INPUT UP TO 5 CATEGORY NUMBERS.

?
1 2
?

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR

?
.20 0 1 12
?

VALUES FOR YEARS 1 TO 12:

	CATEGORY#1	CATEGORY#2	CATEGORY#3	CATEGORY#4	CATEGORY#5
1	0.200	0.200	0.0	0.0	0.0
2	0.200	0.200	0.0	0.0	0.0
3	0.200	0.200	0.0	0.0	0.0
4	0.200	0.200	0.0	0.0	0.0
5	0.200	0.200	0.0	0.0	0.0

FIGURE 4-10
CREATION OF A FINANCIAL MODULE
(CONTINUED)

6	0.200	0.200	0.0	0.0	0.0
7	0.200	0.200	0.0	0.0	0.0
8	0.200	0.200	0.0	0.0	0.0
9	0.200	0.200	0.0	0.0	0.0
10	0.200	0.200	0.0	0.0	0.0
11	0.200	0.200	0.0	0.0	0.0
12	0.200	0.200	0.0	0.0	0.0

INPUT UP TO 5 CATEGORY NUMBERS.

?
3 4
?

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR

?
.14 0 1 12
?

VALUES FOR YEARS 1 TO 12:
CATEGORY#1 CATEGORY#2 CATEGORY#3 CATEGORY#4 CATEGORY#5

1	0.200	0.200	0.140	0.140	0.0
2	0.200	0.200	0.140	0.140	0.0
3	0.200	0.200	0.140	0.140	0.0
4	0.200	0.200	0.140	0.140	0.0
5	0.200	0.200	0.140	0.140	0.0
6	0.200	0.200	0.140	0.140	0.0
7	0.200	0.200	0.140	0.140	0.0
8	0.200	0.200	0.140	0.140	0.0
9	0.200	0.200	0.140	0.140	0.0
10	0.200	0.200	0.140	0.140	0.0
11	0.200	0.200	0.140	0.140	0.0
12	0.200	0.200	0.140	0.140	0.0

INPUT UP TO 5 CATEGORY NUMBERS.

?

DEPLETION ALLOWANCE RATES -
DEFAULTS = 0.15

ENTER VALUE, RATE OF CHANGE, FIRST YEAR & LAST YEAR.

?

VALUES FOR YEARS 1 TO 12:
0.150 0.150 0.150 0.150 0.150
0.150 0.150 0.150 0.150 0.150
0.150 0.150

FINANCIAL CASE CHANGE ROUTINE - PARAMETER MENU

FINANCIAL CASE NAME---SAMPLE

1 BASE YEAR	(1)	15 SINKING FUND DEPOSITS	(50)
2 POWER-ON-LINE YEAR	(1)	16 SINKING FUND INT. RATE	(1)
3 PROJECT LIFE	(1)	17 GEN. INFLATION RATE	(50)
4 LOAN LIFE	(1)	18 ESC. RATE-CAPITAL COSTS	(5,50)
5 WORKING CAPITAL	(1)	19 ESC. RATE-ELECT. PRICE	(50)
6 ELECTRICITY PRICE	(1)	20 ESC. RATE-FLUID PRICE	(50)
7 FLUID PRICE	(1)	21 ESC. RATE-O & H	(50)
8 CAPACITY FACTOR	(50)	22 DISCOUNT RATE	(50)
9 MIN. TOTAL EQUITY FRAC.	(1)	23 TAX RATE-PROPERTY	(50)
10 MIN. ANNUAL EQUITY FRAC. (1-9)	(1-9)	24 ROYALTY RATE	(50)
11 EQUITY RATE-OF-RETURN	(50)	25 TAX RATE-FED INC	(50)
12 PRINCIPAL PAYMENTS	(50)	26 TAX RATE-STA INC	(50)
13 DEBT INTEREST RATE	(50)	27 TAX CREDIT RATE	(5,50)
14 DOE FEE RATE	(1)	28 DEPLETION ALLOWANCE RATE	(50)

ENTER VARIABLE NUMBER.

A ZERO OR NULL RETURN WILL TERMINATE THE CHANGE ROUTINE.

?

FIGURE 4-10
CREATION OF A FINANCIAL MODULE
(CONCLUDED)

GLGP Cash Flow Model
Data Record Sheet - FINANCIAL INPUT (Sheet 1 of 2)

CASE NAME: Sample

RUN DATE: _____ RUN TIME: _____ RUN NUMBER: _____

						DEFAULT
1	Base Year	1980				1979
2	Power-on-Line Year	1982				
3	Project Life	12				
4	Loan Life	10				
5	Working Capital (K\$)	4000				0.0
6	Elect. Price (Mills/kwh)	140				50.0
7	Fluid Price (Mills/kwh)	70				20.0
Range #		Value	Rate	FY	LY	
8	Capacity #1	0.5	0	3	4	0.0-Con.
	Facto #2	0.9	0	5	12	0.8-Oper.
9	Minimum Equity Fraction	.25				.25
10	Construction	#1 .10	#2 .10	#3	0.0 for	
	Investment Annual	#4	#5	#6	all years	
	Equity Fractions	#7	#8	#9		
Range #		Value	Rate	FY	LY	
11	Equity Rate of #1	.00	0	1	12	0.0 for
	Return #2	.30	0	3	12	all years
12	Payments on #1	0	0	1	12	Calculated
	Debt #2					
13	Debt Interest #1	.15	0	1	12	0.0 for
	Rate #2					all years
14	DOE Fee Rate	.01				.01
Range #		Value	Rate	FY	LY	
15	Sinking Fund #1	0	0	1	12	Calculated
	Deposits #2					
16	Sinking Fund Int. Rate	0.10				0.0

FIGURE 4-11
FINANCIAL ROUTINE INPUT SHEET

RUN DATE: _____ RUN TIME: _____ RUN NUMBER: _____

	Range #	Value	Rate	FY	LY	Default
17 General	#1	0.12	0	1	12	0.0 for all years
Inflation Rate	#2					
18 Escalation	#1,2	0.16	0	1	12	0.0 for all years
Rate for	#3,4	0.11	0	1	12	
Capital Costs	# 5	0	0	1	12	
	#					
	#					
	#					
19 Escalation Rate	#1	0.12	0	1	12	0.0 for all years
Electricity Price	#2					
20 Escalation Rate	#1	0.14	0	1	12	0.0 for all years
Fluid Price	#2					
21 Escalation Rate	#1	0.12	0	1	12	0.0 for all years
O&M Costs	#2					
22 Discount Rate	#1	0.16	0	1	12	0.0 for all years
	#2					
23 Property Tax	#1	0.02	0	1	12	0.0 for all years
Rate	#2					
24 Royalty Rate	#1	0.05	0	1	12	0.0 for all years
	#2					
25 Federal Income	#1	0.48	0	1	12	0.0 for all years
Tax Rate	#2					
26 State Income	#1	0.05	0	1	12	0.0 for all years
Tax Rate	#2					
27 Investment	#1,2,3,4	0.20	0	1	12	0.0 for all years
Tax Credit Rate#	5	0.10	0	1	12	
	#					
	#					
	#					
28 Depletion	#1	0.18	0	1	3	.15 for all years
Allowance Rate	#2					

FIGURE 4-11
FINANCIAL ROUTINE INPUT SHEET
(CONCLUDED)

Figure 4-12 shows the execution of the field module when an existing financial case is used without changes.

4.5 Data Change Procedure

Each of the three modules contains a change routine to facilitate alteration of the input parameters. The cycle design routine contains its own change routine which is slightly different from the main change routines. Figure 4-13 shows an example of a change being made. The other three change routines are of the same format, as shown in Figure 4-14, for the field module.

4.6 Case Deletion Procedure

If the user selects the name of an existing project, he will be given the option of deleting it. Figure 4-15 shows the steps taken for deleting an existing power plant, field or financial case. As a precaution the user must verify any deletion request by answering a second question. This prevents the user from accidentally deleting an important project.

4.7 Warning Messages

GCFM does not supply default values for all required input variables. In those cases the user must enter a value if the program is to run properly. The program is designed to display error messages when needed as shown in Figure 4-16. It is not possible, however, to verify all data entries, so there are still many ways the user can cause errors with the use of improper data.

ENTER FINANCIAL CASE NAME (UP TO 20 CHARACTERS) .

sample
 A FINANCIAL CASE ALREADY EXISTS UNDER THAT NAME.

DO YOU WISH TO DELETE IT? (Y OR N)

n
 DO YOU WISH TO CHANGE THE FINANCIAL INPUT PARAMETERS? (Y OR N)

n
 DO YOU WISH TO PERFORM A FINANCIAL ANALYSIS? (Y OR N) .

y
 DO YOU WISH TO CREATE A SINKING FUND? (Y OR N)

n
 DOES THE PROJECT PAY INCOME TAXES? (Y OR N)

n
 ENTER FINANCIAL CASE NAME (UP TO 20 CHARACTERS) .

ENTER FIELD NAME (UP TO 20 CHARACTERS) .

WELCOME TO THE GEOTHERMAL LOAN GUARANTY CASH FLOW MODEL.
 MODULES AVAILABLE
 1 = POWER PLANT DESIGN MODULE
 2 = FIELD DESIGN MODULE
 3 = FINANCIAL MODULE
 ENTER NUMBER OF MODULE DESIRED?

?

FIGURE 4-12
EXECUTION OF AN EXISTING FINANCIAL ROUTINE

GEYSER

DRY STEAM

NUMBER	PARAMETER	CURRENT VALUE
1	TEMPERATURE OF STEAM (DEG.F.)	355.00000
2	PRESSURE OF STEAM (PSI)	113.70000
3	GAS CONTENT (%)	1.00000
4	PLANT NET SALES OUTPUT (MW)	106.00000
5	GENERATOR EFFICIENCY (%)	98.00000
6	TURBINE EFFICIENCY (%)	70.00000
7	TURBINE OUTLET TEMPERATURE (DEG.F.)	130.00000
8	COOLING WATER TEMPERATURE (DEG.F.)	80.00000
9	CONDENSER OUTLET TEMPERATURE (DEG.F.)	118.39999
10	DESIGN WET BULB TEMPERATURE (DEG.F.)	65.00000
11	HEIGHT OF COOLING TOWER (FT.)	0.0
12	PUMP AND PIPING MATERIAL (1=CS,2=SS)	0
13	PUMP DRIVER TYPES (1=MOTOR,2=TURBINE)	0
14	COOLING TOWER TYPE (1=WET,2=DRY)	0
15	COOLING TOWER MATERIAL (1=WOOD,2=CONCRETE)	1

ENTER VARIABLE NUMBER AND THE NEW VALUE.

A ZERO OR NULL RETURN WILL TERMINATE THE CHANGE ROUTINE.

?

1 400

GEYSER

DRY STEAM

NUMBER	PARAMETER	CURRENT VALUE
1	TEMPERATURE OF STEAM (DEG.F.)	400.00000
2	PRESSURE OF STEAM (PSI)	113.70000
3	GAS CONTENT (%)	1.00000
4	PLANT NET SALES OUTPUT (MW)	106.00000
5	GENERATOR EFFICIENCY (%)	98.00000
6	TURBINE EFFICIENCY (%)	70.00000
7	TURBINE OUTLET TEMPERATURE (DEG.F.)	130.00000
8	COOLING WATER TEMPERATURE (DEG.F.)	80.00000
9	CONDENSER OUTLET TEMPERATURE (DEG.F.)	118.39999
10	DESIGN WET BULB TEMPERATURE (DEG.F.)	65.00000
11	HEIGHT OF COOLING TOWER (FT.)	0.0
12	PUMP AND PIPING MATERIAL (1=CS,2=SS)	0
13	PUMP DRIVER TYPES (1=MOTOR,2=TURBINE)	0
14	COOLING TOWER TYPE (1=WET,2=DRY)	0
15	COOLING TOWER MATERIAL (1=WOOD,2=CONCRETE)	1

ENTER VARIABLE NUMBER AND THE NEW VALUE.

A ZERO OR NULL RETURN WILL TERMINATE THE CHANGE ROUTINE.

?

FIGURE 4-13
DATA CHANGE (MODIFY) PROCEDURE FOR PLANT MODULE

POWER PLANT DESIGN DATA CHANGE ROUTINE - PARAMETER MENU

POWER PLANT NAME--GEYSER

1 BASE YEAR	(1)	9 BOOK LIVES-PLANT CAP.	(5)
2 PLANT COST INDEX	(1)	10 TAX LIVES -PLANT CAP.	(5)
3 PROJECT LIFE	(1)	11 SALV RATES-PLANT CAP.	(5)
4 POWER-ON-LINE YEAR	(1)	12 O&M RATES -PLANT CAP.	(5)
5 P.P. NET SALES OUTPUT	(1)	13 OTHER OPERATING COSTS	(50)
6 P.P. TURBINE RATING	(1)	14 SUNK COSTS	(1)
7 BRINE FLOW REQUIRED	(1)	15 CAPITAL INV. SPREAD	(1-9)
8 PLANT CAPITAL COSTS	(5)		

ENTER VARIABLE NUMBER.

A ZERO OR NULL RETURN WILL TERMINATE THE CHANGE ROUTINE.

?

14

PARAMETER - SUNK COSTS
CURRENT VALUE - 0.0

ENTER NEW VALUE

?

2100

POWER PLANT DESIGN DATA CHANGE ROUTINE - PARAMETER MENU

POWER PLANT NAME--GEYSER

1 BASE YEAR	(1)	9 BOOK LIVES-PLANT CAP.	(5)
2 PLANT COST INDEX	(1)	10 TAX LIVES -PLANT CAP.	(5)
3 PROJECT LIFE	(1)	11 SALV RATES-PLANT CAP.	(5)
4 POWER-ON-LINE YEAR	(1)	12 O&M RATES -PLANT CAP.	(5)
5 P.P. NET SALES OUTPUT	(1)	13 OTHER OPERATING COSTS	(50)
6 P.P. TURBINE RATING	(1)	14 SUNK COSTS	(1)
7 BRINE FLOW REQUIRED	(1)	15 CAPITAL INV. SPREAD	(1-9)
8 PLANT CAPITAL COSTS	(5)		

ENTER VARIABLE NUMBER.

A ZERO OR NULL RETURN WILL TERMINATE THE CHANGE ROUTINE.

?

FIGURE 4-14
DATA CHANGE (MODIFY) PROCEDURE FOR FIELD MODULE

WELCOME TO THE GEOTHERMAL LCM GUARANTY CASH FLOW MODEL.
MODULES AVAILABLE
1 = POWER PLANT DESIGN MODULE
2 = FIELD DESIGN MODULE
3 = FINANCIAL MODULE
ENTER NUMBER OF MODULE DESIRED?

?

3

CURRENT FINANCIAL CASE NAMES:

BASLINE

DEMO

KEN

TEST1

GELCOM

NEW

SAMPLE

MARK

BRAW

TESTOR

GEYSER

TPC-GEYSER

IMPERIAL-X

ENTER FINANCIAL CASE NAME (UP TO 20 CHARACTERS).

ken

A FINANCIAL CASE ALREADY EXISTS UNDER THAT NAME.

DO YOU WISH TO DELETE IT? (Y OR N)

y

VERIFICATION OF FINANCIAL CASE DELETION REQUEST - DELETE? (Y OR N)

y

ENTER FINANCIAL CASE NAME (UP TO 20 CHARACTERS).

FIGURE 4-15
DELETION OF AN EXISTING CASE

ENTER BASE YEAR AND COST INDEX (1979=100). (2)
DEFAULT - BASE YEAR = 1979
- COST INDEX = 100.0

?
1980
?

ENTER PROJECT LIFE AND POWER-ON-LINE YEAR. (2)
*** NO DEFAULTS ***

?

*** ERROR ***

FIELD LIFE LESS THAN 1 YEAR---RESET TO 50 YEARS
*** ERROR ***

THE POWER-ON-LINE YEAR IS LESS THAN THE BASE YEAR---RESET TO 1981

DO YOU WISH TO PERFORM A FINANCIAL ANALYSIS? (Y OR N).

y

DO YOU WISH TO CREATE A SINKING FUND? (Y OR N)

y

THE PROJECT POWER-ON-LINE YEAR (1981) AND
THE FINANCIAL CASE POWER-ON-LINE YEAR (1982) ARE NOT EQUAL.
MODEL RESULTS MAY BE UNPREDICTABLE.

THE PROJECT LIFE (32) AND FINANCIAL CASE LIFE (12) ARE NOT EQUAL.
MODEL RESULTS MAY BE UNPREDICTABLE.

THE PROJECT BASE YEAR (1979) AND
FINANCIAL CASE BASE YEAR (1980) ARE NOT EQUAL.
MODEL RESULTS MAY BE UNPREDICTABLE.

ENTER FINANCIAL CASE NAME (UP TO 20 CHARACTERS).

FIGURE 4-16
EXAMPLE OF ERROR CORRECTION WHEN REQUIRED
DATA IS NOT ENTERED

4.8 Termination of GCFM

When the user has completed the execution of any module it will prompt the user to enter the keyword name of the next case or the number of the next module to be used. If the user wishes to terminate the program, a null return may be used as the response to all remaining prompts. This is shown in Figure 4-17.

ENTER FINANCIAL CASE NAME (UP TO 20 CHARACTERS).

ENTER FIELD NAME (UP TO 20 CHARACTERS).

WELCOME TO THE GEOTHERMAL LOAN GUARANTY CASH FLOW MODEL.
MODULES AVAILABLE

1 = POWER PLANT DESIGN MODULE

2 = FIELD DESIGN MODULE

3 = FINANCIAL MODULE

ENTER NUMBER OF MODULE DESIRED?

?

THANK YOU FOR USING GCFM

R; T=31.25/77.84 15:50:33

**FIGURE 4-17
TERMINATION OF GCFM**

5.0 MODEL OUTPUT

This section discusses the output generated by GCFM. Each of the three modules generate one or more printed reports at execution time. For the purposes of this section the Cycle Design Routine is considered part of the Power Plant Module. The Figures referred to in this section start on page 5-6.

5.1 Power Plant Module

5.1.1 Cycle Design Routine

When the cycle design routine is used, the model generates two reports which summarize the input and output to the Cycle Design Routine. The first report summarizes the input parameters. If there is an asterisk by the value, the model has used a default value. This report is shown in Figure 5.1. The second report, shown in Figure 5.2., lists the results of the cycle design, listing the major calculated values, including the brine flow requirement and the turbine rating. This collection of values allows the user to verify the results against an existing design.

5.1.2 Power Plant Design

The Power Plant Modules basic report is the "Power Plant Design and Capital Cost Report" shown in Figures 5-3 and 5-4. This report summarizes the capital costs, asset lives, O&M costs and other parameters relating to power plant life cycle costing. The difference between the reports in Figures 5-3 and 5-4 is simple. The report in Figure 5-3 shows itemized capital costs that were generated by the power plant cycle design. Figure 5-4 shows the same report. The only difference

is that the capital costs were entered via the power plant design change routine or the costs were entered without execution of the cycle design routine.

5.2 Field Module

The field module produces a single report titled the "Field Design and Capital Cost Report" shown in Figure 5-5. This report summarizes the capital costs, asset lives, O&M costs and other parameters relating to field life cycle costing.

At the end of the report the module summarizes the source of selected parameters relating to the field, i.e. the well costs, well flow rates and capital costs. This is helpful because it tells the user whether or not the values were based on defaults or on entered data.

5.3 Financial Module

When the financial module is executed the model generates a set of financial reports which represent the life cycle costs of the power plant or field project.

5.3.1 Construction Period

The construction period report (#F1.1) details the annual and cumulative debt, equity investments and financing charges for the project for which the financial module is performing calculations. Figure 5-6 is an example of this report.

The same information is given regardless of the tax status of the organization, and the method of calculation.

5.3.2 Operating Life

The financial routine produces two sets of reports which detail the annual calculations for revenues, expenses, taxes and cash flows. Each of the two sets corresponds to a different method of calculating the net cash flow. The first set of reports (#F2.1-F2.6) relate to the market price analysis, while the second set of reports (#F3.1-F3.6) relate to the annual breakeven price analysis (cost of power analysis). The financial module always generates both sets of reports.

For the most part, the format of both sets of reports are identical. As such, the descriptions of most of the reports are generic. Differences will be identified on a report by report basis.

Revenue Report

This report (#F2.1 and F3.1), shown in Figure 5-7 and 5-8, details the annual values for sales output, price, revenue, operating expenses and taxable income for the project in question. The only difference between market price and breakeven price reports is that the breakeven price report includes a levelized breakeven cost of power, as shown in Figure 5-8.

Income Tax Reports

The income tax reports are shown in Figures 5-9 and 5-10. These reports contain: before-tax income or loss, tax loss carried forward, taxable income, income tax liability, income tax credits, taxes paid, before-tax income or loss, and after-tax income or loss.

Cash Flow Reports

The cash flow report (#F2.2 and F3.2) shown in Figures 5-11 and 5-12 picks up where the revenue report leaves off. This report details the annual income tax status of the project and estimates the annual cash flow, factoring indebt retirement or sinking fund deposits. The only difference between the two reports is that the market price report includes a Discounted Cash Flow Rate of Return which is calculated based on a discount rate and the annual cash flows.

Cash Flow Pattern

The Cash Flow Pattern Reports (F2.4 and F3.4) shown in Figure 5-13 details the annual and cummulative cash flows in two ways. The first is a listing of the nominal annual cash flows and accumulation, while the second is a listing of the discounted cash flows and accumulation.

This report is run using the no-income tax option, shown in Figure 5-14. The format of the two reports is identical with the exception of the report number, and as such only one copy is included in this document.

Operation Expense Report

The operating expense reports (F2.5 and F3.5), shown in Figure 5-15, detail the breakdown of the annual operating expenses, including any tax depreciation. The format of this report is identical in both cases with the exception of the report number.

Sinking Fund Activity Report

When the user specifies that a sinking fund is to be used, reports (F2.6 and F3.6) Figure 5-16 are added to the financial module output. The report details deposits, withdrawals, interest and taxes relating to the accumulation of money for replacement equipment. This report also includes an annual recap of all investment activity. The format of this report is identical in both cases, with the exception of the report number.

Data Dump Reports

At the end of each execution of the power plant module, field module, of financial module GCFM prints a "data dump" report. This report is a record of the input assumptions that were used to calculate the results of each run. An example of the data dump report from the financial module is shown in Figure 5-17.

GLGP CASH FLOW MODEL
POWER PLANT CYCLE CALCULATION ROUTINE
INPUT PARAMETER REPORT

SAMPLE
50.0 MW BINARY

RESERVOIR CONDITION INPUT PARAMETERS:

TEMPERATURE OF UNFLASHED FLUID (DEG.F.)	450.0
PRESSURE OF UNFLASHED FLUID (PSI)	430.0
REINJECTION TEMPERATURE (DEG.F.)	234.0
REINJECTION PRESSURE (PSI)	370.0
DISOLVED SOLIDS (PPM)	0.0*

PLANT DESIGN INPUT PARAMETERS:

PLANT NET SALES OUTPUT (MW)	50.0
GENERATOR EFFICIENCY (%)	98.0
TURBINE EFFICIENCY (%)	85.0
W. F. TEMPERATURE-TURBINE INLET (DEG.F.) ...	373.0
W. F. PRESSURE-TURBINE INLET (PSI)	1600.0
W. F. PRESSURE-TURBINE OUTLET (PSI)	70.0
COOLING WATER TEMPERATURE-CCND. INLET	90.0
COOLING WATER TEMPERATURE-COND. OUTLET	101.0
DESIGN WET BULB TEMP (DEG.F.)	80.0
HEIGHT OF COOLING TOWER (FT.)	40.0

EQUIPMENT TYPE INPUT PARAMETERS:

PUMP AND PIPING MATERIAL (1=CS,2=SS)	2
PUMP DRIVER TYPES (1=MOTOR,2=TURBINE)	1
COOLING TOWER TYPE (1=WET,2=DRY)	1
COOLING TOWER MATERIAL (1=WOOD,2=CONCRETE) .	1

FIGURE 5-1
CYCLE DESIGN ROUTINE, IMPACT PARAMETER REPORT

GLGP CASH FLOW MODEL
POWER PLANT CYCLE CALCULATION ROUTINE
CYCLE CALCULATIONS REPORT

SAMPLE
50.0 MW BINARY

PLANT DESIGN REQUIREMENTS:

TURBINE RATING (MW)	68.8
TURBINE EXHAUST TEMPERATURE (DEG. F.)	127.6
WORKING FLUID-CONDENSER OUTLET TEMP.	98.4
AREA OF HEAT EXCHANGER (SQ FT)	50118.3
AREA OF CONDENSER (SQ FT)	398854.4

FLOW RATES:

WORKING FLUID FLOW (K LB/HR)	5435.1
BRINE FLOW (K LB/HR)	4692.5
COOLING WATER FLOW (K LB/HR)	70623.7

PUMPS:

WORKING FLUID-BOOSTER (HORSEPOWER)	6571.3
WORKING FLUID-FEED (HORSEPOWER)	13142.5
COOLING WATER (HORSEPOWER)	1550.6
RE-INJECTION (HORSEPOWER)	594.2

COOLING TOWER:

HEAT REJECTED (M BTU/HR)	776.9
DRAFT FAN (HORSEPOWER)	1571.8

FIGURE 5-2
CYCLE DESIGN ROUTINE, CALCULATIONS REPORT

POWER PLANT NAME	-SAMPLE		
PLANT NET OUTPUT (MWE)	- 50.0	POWER PLANT CYCLE TYPE	-ERINE BINARY
BASE YEAR	- 1980	POWER-ON-LINE YEAR	- 1982
PROJECT LIFE	- 12	COST INDEX (1979=100.0)	-115.0

ACCT	NAME	COST (K\$)	BOOK LIFE	TAX LIFE	TOTAL COST (K\$)	SALVAGE RATE	O & M RATE
1	TURBOGENERATOR	4407.6	10	10	11376.3	0.0	0.050
	VAPOR GENERATOR	2258.8					
	CONDENSER	3642.5					
	FLASH VESSELS	0.0					
	COOLING TOWERS	1067.3					
2	COOLING WATER PUMP	1478.0	5	5	9852.3	0.0	0.100
	RE-INJECTION PUMP	1161.8					
	W. F. BOOSTER PUMP	1221.6					
	W. F. FEED PUMP	5991.0					
3	PIPING & INSULATION	2099.0	5	5	5308.9	0.0	0.050
	MISC. PROCESS EQUIPMENT	322.9					
	INSTRUMENTS & CONTROLLERS	1861.0					
	ELECTRIC SUPPORT EQUIP	1025.9					
4	CRANE	393.6	10	10	5770.6	0.0	0.050
	BUILDING & STRUCTURES	3682.9					
	SWITCH YARD	1694.2					
5	INDIRECT COSTS	3230.8	10	5	13892.4	0.0	0.0
	ENGINEERING COSTS	4264.7					
	CONTRACTORS FEE	1776.9					
	CONTINGENCY	4620.0					

FIGURE 5-3

5-8

**GLGP CASH FLOW MODEL
POWER PLANT DESIGN & CAPITAL COST REPORT**

POWER PLANT NAME	-SAMPLE	POWER PLANT CYCLE TYPE	-BRINE BINARY
PLANT NET OUTPUT (MWE)	- 50.0	POWER-ON-LINE YEAR	- 1982
BASE YEAR	- 1980	COST INDEX (1979=100.0)	-115.0
PROJECT LIFE	- 12		

CAPITAL ACCOUNTS DATA:

	TOTAL COST (K\$)	BOOK LIFE	TAX LIFE	SALVAGE RATE	O & M RATE
CAPITAL CATEGORY #1	10000.0	10	10	0.0	0.050
CAPITAL CATEGORY #2	7000.0	5	5	0.0	0.100
CAPITAL CATEGORY #3	4000.0	5	5	0.0	0.050
CAPITAL CATEGORY #4	6000.0	10	10	0.0	0.050
CAPITAL CATEGORY #5	11000.0	10	5	0.0	0.0

CAPITAL COST OF POWER PLANT COMPONENTS (K\$) 38000.0

SUNK COSTS (K\$) 4000.0

TOTAL CAPITAL COST OF POWER PLANT (K\$) 42000.0

TOTAL BRINE FLOW REQUIRED BY PLANT (K LB/HR) 4692.5

POWER PLANT GROSS OUTPUT (MWE). 68.8

**FIGURE 5-4
POWER PLANT DESIGN AND CAPITAL COST REPORT (PAGE 2)**

**GLGP CASH FLOW MODEL
FIELD DESIGN & CAPITAL COST REPORT**

FIELD NAME	-SAMPLE	POWER PLANT TYPE	-BINARY
FIELD SIZE (MWE GROSS)	- 50.0	POWER-ON-LINE YEAR	- 1982
BASE YEAR	- 1980	COST INDEX (1979=100.0)	-115.0
PROJECT LIFE	- 12		

RESERVOIR INPUT DATA:

RESOURCE TEMPERATURE (DEG.F)	450.0
WELL DEPTH (FEET)	5000.0
DISSOLVED SOLIDS (PPM)	0.0
ROCK TYPE	MEDIUM

BRINE FLOW RATES:

BRINE FLOW FROM FIELD (K LB/HR)	4692.5
PRODUCTION WELL FLOW (K LB/HR)	600.0
REINJECTION WELL FLOW (K LB/HR)	2436.4

CAPITAL ACCOUNTS DATA:

ACCT	NAME	COST (K\$)	BOOK LIFE	TAX LIFE	NUMBER	TOTAL SALVAGE COST (K\$)	INDC RATE	O & B RATE
1	PRODUCTION WELLS	828.0 EA	10	6	8	6624.0	0.0	0.750 0.100
2	INJECTION WELLS	690.0 EA	10	6	2	1380.0	0.0	0.750 0.100
3	DOWN HOLE PUMPS	250.0 EA	10	10	8	2000.0	0.0	N/A 0.400
4	PROCESS MECHANICAL INSTRUMENTATION & CONTROL GATHERING SYSTEM DISTRIBUTION SYSTEM SPENT BRINE TREATMENT	388.1 958.4 516.2 776.3 516.2	10	10	N/A	3155.2	0.0	N/A 0.0
5	ENGINEERING & ADMINISTRATION	2064.8	10	5	N/A	2064.8	0.0	N/A 0.0
TOTAL COST OF WELLS (\$000)			8004.0					
COST OF DOWN HOLE PUMPS (\$000)			2000.0					
FIELD EQUIPMENT COSTS (\$000)			5220.0					
FIELD EXPLORATION COSTS (\$000)			3000.0					
CAPITALIZED DRY HOLE EXPENSES (\$000)			1656.0					
TOTAL CAPITAL COST (\$000)			19880.0					
SUNK COSTS (\$000)			4000.0					
CAPITAL COST (INCLUDING SUNK COSTS)			23880.0					

FIELD ELECTRICITY CONSUMPTION (MWE) 0.0

-COSTS PER PRODUCTION AND INJECTION WELLS HAVE
BEEN CALCULATED BY THE DESIGN PROGRAM.

-FIELD CAPITAL COSTS HAVE BEEN CALCULATED BY THE DESIGN PROGRAM.

-FLOW RATES HAVE BEEN CALCULATED BY THE DESIGN PROGRAM.

-DOWN HOLE PUMPS ARE BEING USED IN THIS CASE.

**FIGURE 5-5
FIELD DESIGN - DESIGN AND CAPITAL COST REPORT**

**GLGP CASH FLOW MODEL
CONSTRUCTION PERIOD #F1.1**

**PROJECT NAME - SAMPLE
PROJECT TYPE - POWER PLANT**

**FINANCIAL CASE NAME - SAMPLE
FINANCIAL STRUCTURE - TAXABLE ENTITY**

YEAR	CONSTRUCTION COST	ANNUAL INTEREST	ANNUAL DOE FEE	ANNUAL DEBT	ANNUAL EQUITY	CUMULATIVE DEBT	CUMULATIVE EQUITY	EQUITY FRACTION
SUNK COSTS	4000.0	0.0	0.0	0.0	4000.0	0.0	4000.0	1.000
1 - 1980	9500.0	1739.5	51.7	10341.2	950.0	10341.2	4950.0	0.324
2 - 1981	31365.0	7075.9	221.1	33886.9	9792.7	44228.1	14742.7	0.250
WORK CAP.*	5017.6							
TOTAL	49882.6	8815.4	272.8	44228.1	14742.7			

* - WORKING CAPITAL INVESTMENT MADE DURING THE FOURTH QUARTER OF THE FINAL CONSTRUCTION YEAR.
CONSTRUCTION BUDGET (K\$/1980):

SUNK EQUITY COSTS	=	4000.0	MINIMUM EQUITY FRACTION	=	0.250
PROJECT CAPITAL COST	=	40865.0	DOE FEE	=	0.010
WORKING CAPITAL	=	5017.6			
TOTAL (LESS FINANCING)	=	49882.6			
DOE FEE'S AND INTEREST	=	9088.3			
TOTAL CAPITAL COST	=	58970.9			

YEAR	INTEREST RATE	INVESTMENT BREAKDOWN	ANNUAL ** TAX LOSSES
1 - 1980	0.180	0.250	1791.2
2 - 1981	0.180	0.750	7297.1

** - ANNUAL TAX LOSSES INCLUDE CONSTRUCTION PERIOD DRY HOLE EXPENSES, EXPLORATION COSTS, INTANGIBLE DRILLING COSTS, DOE FEES, AND INTEREST.

**FIGURE 5-6
FIELD AND POWER PLANT DESIGNS, FINANCIAL
CONSTRUCTION PERIOD REPORT**

GLGF CASH FLOW MODEL
OPERATION PERIOD REPORT #F2.1

MARKET PRICE - REVENUE REPORT

PROJECT NAME - SAMPLE
PROJECT TYPE - POWER PLANT

FINANCIAL CASE NAME - SAMPLE
FINANCIAL STRUCTURE - TAXABLE ENTITY

YEAR	P.P. NET * (K-MWH)	PRICE** X (MIL/KWH)	SALES = REVENUE +	SALVAGE REVENUE =	TOTAL REVENUE -	OPERATING EXPENSES =	BEFORE TAX INCOME/LOSS
3 - 1982	219.1	175.6	38486.2	0.0	38486.2	52362.2	-13876.0
4 - 1983	394.5	196.7	77588.1	0.0	77588.1	80772.6	-3184.5
5 - 1984	394.5	220.3	86898.7	0.0	86898.7	86747.8	150.9
6 - 1985	394.5	246.7	97326.5	0.0	97326.5	93918.6	3408.0
7 - 1986	394.5	276.3	109005.6	0.0	109005.6	102941.2	6064.5
8 - 1987	394.5	309.5	122086.2	0.0	122086.2	121152.1	934.2
9 - 1988	394.5	346.6	136736.6	0.0	136736.6	129428.7	7307.9
10 - 1989	394.5	388.2	153144.9	0.0	153144.9	142952.1	10192.9
11 - 1990	394.5	434.8	171522.2	0.0	171522.2	159101.0	12421.3
12 - 1991	394.5	487.0	192104.9	0.0	192104.9	178399.7	13705.3

* - THEORETICAL OUTPUT = 438.3 K-MWH/YEAR (ASSUMES A CAPACITY FACTOR OF 100%)
AVERAGE CAPACITY FACTOR = 86.0 %
AVERAGE OUTPUT = 376.9 K-MWH/YEAR

** - MARKET PRICE ESCALATED AT AVERAGE ANNUAL RATE OF 12.0 %

FIGURE 5-7
FIELD AND POWER PLANT DESIGNS, FINANCIAL
OPERATIONAL MARKET PRICE-REVERSE REPORT

GLGP CASH FLOW MODEL
OPERATION PERIOD REPORT #F3.1

BREAKEVEN PRICE - REVENUE REPORT

PROJECT NAME - SAMPLE
PROJECT TYPE - POWER PLANT

FINANCIAL CASE NAME - SAMPLE
FINANCIAL STRUCTURE - TAXABLE ENTITY

YEAR	P.P. NET * (K-MWH)	PRICE** X (MIL/KWH)	SALES = REVENUE +	SALVAGE REVENUE =	TOTAL REVENUE -	OPERATING EXPENSES =	BEFORE TAX INCOME/LCSS
3 - 1982	219.1	245.0	53681.1	0.0	53681.1	53122.0	559.2
4 - 1983	394.5	208.8	82383.2	0.0	82383.2	81012.4	1370.8
5 - 1984	394.5	225.7	89037.3	0.0	89037.3	86854.7	2182.6
6 - 1985	394.5	245.6	96891.1	0.0	96891.1	93896.8	2994.4
7 - 1986	394.5	324.9	128169.0	0.0	128169.0	103899.4	24269.7
8 - 1987	394.5	318.5	125636.4	0.0	125636.4	121329.6	4306.9
9 - 1988	394.5	368.4	145304.2	0.0	145304.2	129857.1	15447.2
10 - 1989	394.5	408.5	161153.9	0.0	161153.9	143352.5	17801.5
11 - 1990	394.5	416.6	164349.3	0.0	164349.3	158742.4	5607.0
12 - 1991	394.5	462.7	182524.6	0.0	182524.6	177920.7	4603.9

LEVELIZED BREAKEVEN PRICE (CONSTANT-CURRENT DOLLARS) =293.8 MILLS/KWH

LEVELIZED BREAKEVEN PRICE (1980 DOLLARS) =148.6 MILLS/KWH
ASSUMES AN AVERAGE ANNUAL PRICE ESCALATION OF 12.0 % BEGINNING IN 1980

* - THEORETICAL OUTPUT = 438.3 K-MWH/YEAR (ASSUMES A CAPACITY FACTOR OF 100%)
AVERAGE CAPACITY FACTOR = 86.0 %
AVERAGE OUTPUT = 376.9 K-MWH/YEAR

FIGURE 5-8
FIELD AND POWER PLANT DESIGNS, FINANCIAL
OPERATIONAL BREAKEVEN PRICE REVENUE REPORT

GLGF CASH FLOW MODEL
OPERATION PERIOD REPORT #F2.2

MARKET PRICE - INCOME TAX REPORT

PROJECT NAME - SAMPLE
PROJECT TYPE - POWER PLANT

FINANCIAL CASE NAME - SAMPLE
FINANCIAL STRUCTURE - TAXABLE ENTITY

YEAR	BEFORE TAX INCOME/LCSS	TAX LOSS - FORWARD =	TAXABLE ** INCOME **	INCOME TAX LIABILITY -	INCOME TAX CREDITS =	TAXES ** PAID **	BEFORE TAX INCOME/LCSS	TAXES - PAID =	AFTER TAX INCOME/LOSS
3 - 1982	-13876.0	0.0	-13876.0 **	0.0	0.0	0.0 **	-13876.0	0.0	-13876.0
4 - 1983	-3184.5	0.0	-3184.5 **	0.0	0.0	0.0 **	-3184.5	0.0	-3184.5
5 - 1984	150.9	150.9	0.0 **	12.5	12.5	0.0 **	150.9	0.0	150.9
6 - 1985	3408.0	3408.0	0.0 **	12.5	12.5	0.0 **	3408.0	0.0	3408.0
7 - 1986	6064.5	6064.5	0.0 **	12.5	12.5	0.0 **	6064.5	0.0	6064.5
8 - 1987	934.2	934.2	0.0 **	0.0	0.0	0.0 **	934.2	0.0	934.2
9 - 1988	7307.9	7307.9	0.0 **	12.5	12.5	0.0 **	7307.9	0.0	7307.9
10 - 1989	10192.9	8283.3	1909.7 **	966.3	495.6	470.6 **	10192.9	470.6	9722.3
11 - 1990	12421.3	0.0	12421.3 **	6285.2	3155.1	3130.1 **	12421.3	3130.1	9291.2
12 - 1991	13705.3	0.0	13705.3 **	6934.9	1303.3	5631.6 **	13705.3	5631.6	8073.7

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FIGURE 5-9
FIELD AND POWER PLANT DESIGNS, FINANCIAL
OPERATIONAL MARKET PRICE INCOME TAX REPORT

GLGF CASH FLOW MODEL
OPERATION PERIOD REPORT #F3.2

BREAKEVEN PRICE - INCOME TAX REPORT

PROJECT NAME - SAMPLE
PROJECT TYPE - POWER PLANT

FINANCIAL CASE NAME - SAMPLE
FINANCIAL STRUCTURE - TAXABLE ENTITY

YEAR	BEFORE TAX INCOME/LOSS	TAX LOSS - FORWARD =	TAXABLE ** INCOME **	INCOME TAX LIABILITY -	INCOME TAX CREDITS =	TAXES ** PAID **	BEFORE TAX INCOME/LOSS	TAXES - PAID =	AFTER TAX INCOME/LOSS
3 - 1982	559.2	559.2	0.0 **	0.0	0.0	0.0 **	559.2	0.0	559.2
4 - 1983	1370.8	1370.8	0.0 **	12.5	12.5	0.0 **	1370.8	0.0	1370.8
5 - 1984	2182.6	2182.6	0.0 **	12.5	12.5	0.0 **	2182.6	0.0	2182.6
6 - 1985	2994.4	2994.4	0.0 **	12.5	12.5	0.0 **	2994.4	0.0	2994.4
7 - 1986	24269.7	1981.3	22288.4 **	11277.9	0.0	11277.9 **	24269.7	11277.9	12991.7
8 - 1987	4306.9	0.0	4306.9 **	2179.3	1102.1	1077.1 **	4306.9	1077.1	3229.7
9 - 1988	15447.2	0.0	15447.2 **	7816.3	0.0	7816.3 **	15447.2	7816.3	7630.9
10 - 1989	17801.5	0.0	17801.5 **	9007.6	0.0	9007.6 **	17801.5	9007.6	8793.9
11 - 1990	5607.0	0.0	5607.0 **	2837.1	0.0	2837.1 **	5607.0	2837.1	2769.8
12 - 1991	4603.9	0.0	4603.9 **	2329.6	0.0	2329.6 **	4603.9	2329.6	2274.3

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FIGURE 5-10
FIELD AND POWER PLANT DESIGNS, FINANCIAL
OPERATIONAL BREAKEVEN PRICE INCOME TAX REPORT

GLGF CASH FLOW MODEL
OPERATION PERIOD REPORT #F2.3

MARKET PRICE - CASH FLOW REPORT

PROJECT NAME - SAMPLE
PROJECT TYPE - POWER PLANT

FINANCIAL CASE NAME - SAMPLE
FINANCIAL STRUCTURE - TAXABLE ENTITY

YEAR	AFTER TAX INCOME/LOSS	CASH * + SOURCES	TAX LOSS + FORWARD	DEBT RETIREMENT	GROSS CASH SINK. FUND = FLOW	OTHER CAP.** DEPOSIT - INVESTMENTS	NET CASH = FLOW	
3 - 1982	-13876.0	13226.3	0.0	5528.5	-6178.2	4445.9	0.0	-10624.1
4 - 1983	-3184.5	11550.4	0.0	5528.5	2837.3	4445.9	0.0	-1608.6
5 - 1984	150.9	9874.5	150.9	5528.5	4647.8	4445.9	0.0	201.9
6 - 1985	3408.0	8198.6	3408.0	5528.5	9486.0	4445.9	0.0	5040.0
7 - 1986	6064.5	6522.6	6064.5	5528.5	13123.1	4445.9	0.0	8677.1
8 - 1987	934.2	13025.5	934.2	5528.5	9365.5	0.0	0.0	9365.4
9 - 1988	7307.9	7829.9	7307.9	5528.5	16917.3	0.0	0.0	16917.2
10 - 1989	9722.3	5872.4	8283.3	5528.5	18349.5	0.0	0.0	18349.4
11 - 1990	9291.2	3915.0	0.0	0.0	13206.2	0.0	0.0	13206.1
12 - 1991	8073.7	1957.5	0.0	0.0	10031.2	0.0	0.0	10031.1

DISCOUNTED CASH FLOW RATE OF RETURN = 18.0 % (BASED ON NOMINAL CASH FLOWS)

= 1.3 % (BASED ON PRESENT VALUE OF CASH FLOWS IN 1980 DOLLARS)

* - CASH SOURCES INCLUDES ALL TAX DEPRECIATION, DEPLETION ALLOWANCES, INTANGIBLE DRILLING COSTS, AND DRY HOLE EXPENSES.

** - OTHER CAPITAL INVESTMENTS INCLUDE ANNUAL REPLACEMENT WELL INVESTMENTS, MAKE-UP WELL INVESTMENTS, AND FUNDS REQUIRED TO COVER ANY SINKING FUND SHORTFALLS.

FIGURE 5-11
FIELD AND POWER PLANT DESIGNS, FINANCIAL
OPERATIONAL MARKET PRICE CASH FLOW REPORT

**GLGP CASH FLOW MODEL
OPERATION PERIOD REPORT #F3.3**

BREAKEVEN PRICE - CASH FLOW REPORT

**PROJECT NAME - SAMPLE
PROJECT TYPE - POWER PLANT**

**FINANCIAL CASE NAME - SAMPLE
FINANCIAL STRUCTURE - TAXABLE ENTITY**

YEAR	AFTER TAX INCOME/LOSS	CASH * + SOURCES	TAX LOSS + FORWARD	DEBT - RETIREMENT	GROSS CASH = FLOW	SINK. FUND - DEPOSIT	OTHER CAP.** - INVESTMENTS	NET CASH = FLOW
3 - 1982	559.2	13226.3	559.2	5528.5	8816.1	4445.9	0.0	4370.2
4 - 1983	1370.8	11550.4	1370.8	5528.5	8763.6	4445.9	0.0	4317.7
5 - 1984	2182.6	9874.5	2182.6	5528.5	8711.2	4445.9	0.0	4265.2
6 - 1985	2994.4	8198.6	2994.4	5528.5	8658.8	4445.9	0.0	4212.8
7 - 1986	12991.7	6522.6	1981.3	5528.5	15967.1	4445.9	0.0	11521.2
8 - 1987	3229.7	13025.5	0.0	5528.5	10726.7	0.0	0.0	10726.7
9 - 1988	7630.9	7829.9	0.0	5528.5	9932.3	0.0	0.0	9932.2
10 - 1989	8793.9	5872.4	0.0	5528.5	9137.9	0.0	0.0	9137.8
11 - 1990	2769.8	3915.0	0.0	0.0	6684.8	0.0	0.0	6684.8
12 - 1991	2274.3	1957.5	0.0	0.0	4231.8	0.0	0.0	4231.8

DISCOUNTED CASH FLOW RATE OF RETURN = 37.0 % (BASED ON NOMINAL CASH FLOWS)

= 16.6 % (BASED ON PRESENT VALUE OF CASH FLOWS IN 1980 DOLLARS)

* - CASH SOURCES INCLUDES ALL TAX DEPRECIATION, DEPLETION ALLOWANCES, INTANGIBLE DRILLING COSTS, AND DRY HOLE EXPENSES.

** - OTHER CAPITAL INVESTMENTS INCLUDE ANNUAL REPLACEMENT WELL INVESTMENTS, MAKE-UP WELL INVESTMENTS, AND FUNDS REQUIRED TO COVER ANY SINKING FUND SHORTFALLS.

**FIGURE 5-12
FIELD AND POWER PLANT DESIGNS, FINANCIAL
OPERATIONAL BREAKEVEN PRICE CASH FLOW REPORT**

GLGP CASH FLOW MODEL
OPERATION PERIOD REPORT #P2.4

MARKET PRICE - CASH FLOW PATTERN REPORT

PROJECT NAME - SAMPLE
PROJECT TYPE - POWER PLANT

FINANCIAL CASE NAME - SAMPLE
FINANCIAL STRUCTURE - TAXABLE ENTITY

5-18

YEAR	NET CASH FLOW	SUM OF NET CASH FLOWS	CASH FLOWS DISCOUNTED	SUM DISCOUNTED	UNUSED TAX LOSSES AND TAX CREDITS	TAX LOSSES	TAX CREDITS
1 - 1980	-4950.0	-4950.0	-4950.0	-4950.0	0.0	0.0	0.0
2 - 1981	-9792.7	-14742.7	-8442.0	-13392.0	0.0	0.0	0.0
3 - 1982	-10624.1	-25366.8	-7895.5	-21287.5	0.0	0.0	4777.8
4 - 1983	-1608.6	-26975.4	-1030.5	-22318.0	0.0	0.0	0.0
5 - 1984	201.9	-26773.5	111.5	-22206.5	0.0	0.0	0.0
6 - 1985	5040.0	-21733.5	2399.6	-19806.9	0.0	0.0	0.0
7 - 1986	8677.1	-13056.4	3561.5	-16245.4	0.0	0.0	0.0
8 - 1987	9365.4	-3691.0	3313.8	-12931.7	0.0	0.0	0.0
9 - 1988	16917.2	13226.2	5160.2	-7771.5	0.0	0.0	0.0
10 - 1989	18349.4	31575.6	4825.0	-2946.4	0.0	0.0	0.0
11 - 1990	13206.1	44781.7	2993.6	47.2	0.0	0.0	0.0
12 - 1991	10031.1	54812.9	1960.3	2007.4	0.0	0.0	0.0

FIGURE 5-13
FIELD AND POWER PLANT DESIGNS, FINANCIAL
OPERATIONAL MARKET PRICE CASH FLOW PATTERN
FOR NON-EXEMPT OWNERSHIP

**GLGP CASH FLOW MODEL
OPERATION PERIOD REPORT #F3.4**

BREAKEVEN PRICE - CASH FLOW PATTERN REPORT

**PROJECT NAME - SAMPLE
PROJECT TYPE - POWER PLANT**

**FINANCIAL CASE NAME - SAMPLE
FINANCIAL STRUCTURE - TAXABLE ENTITY**

5-19

YEAR	NET CASH FLOW	SUM OF NET CASH FLOWS	CASH FLOWS DISCOUNTED	SUM DISCOUNTED	UNUSED TAX LOSSES AND TAX CREDITS TAX LOSSES	TAX CREDITS
1 - 1980	-4950.0	-4950.0	-4950.0	-4950.0	0.0	0.0
2 - 1981	-9792.7	-14742.7	-8442.0	-13392.0	0.0	0.0
3 - 1982	4370.2	-10372.5	3247.8	-10144.2	0.0	0.0
4 - 1983	4317.7	-6054.8	2766.1	-7378.1	0.0	0.0
5 - 1984	4265.2	-1789.6	2355.7	-5022.4	0.0	0.0
6 - 1985	4212.8	2423.2	2005.8	-3016.6	0.0	0.0
7 - 1986	11521.2	13944.4	4728.8	1712.1	0.0	0.0
8 - 1987	10726.7	24671.1	3795.4	5507.6	0.0	0.0
9 - 1988	9932.2	34603.3	3029.6	8537.1	0.0	0.0
10 - 1989	9137.8	43741.1	2402.8	10940.0	0.0	0.0
11 - 1990	6684.8	50425.9	1515.3	12455.3	0.0	0.0
12 - 1991	4231.8	54657.7	827.0	13282.2	0.0	0.0

**FIGURE 5-14
FIELD AND POWER PLANT DESIGNS, FINANCIAL
OPERATIONAL MARKET PRICE CASH FLOW PATTERN
FOR TAX EXEMPT OWNERSHIPS**

GLGF CASH FLOW MODEL
OPERATION PERIOD REPORT #F2.5

MARKET PRICE - OPERATING EXPENSE REPORT

PROJECT NAME - SAMPLE
PROJECT TYPE - POWER PIANT

FINANCIAL CASE NAME - SAMPLE
FINANCIAL STRUCTURE - TAXABLE ENTITY

YEAR	ROYALTIES+	O&M/OTHER CCSTS +	FUEL COST +	INTEREST COST +	DOE FEE +	TAX DEPREC. +	PROPERTY TAXES +	IDC/ DHE +	DEPLETION ALLOWANCE	OPERATING EXPENSES
3 - 1982	1924.3	2257.9	27432.6	6323.2	414.6	13226.3	783.2	0.0	0.0	52362.2
4 - 1983	3879.4	2528.9	56291.6	5494.0	359.4	11550.4	669.2	0.0	0.0	80772.6
5 - 1984	4344.9	2832.3	64172.4	4664.7	304.1	9874.5	555.1	0.0	0.0	86747.8
6 - 1985	4866.3	3172.2	73156.4	3835.4	248.8	8198.6	441.0	0.0	0.0	93918.6
7 - 1986	5450.3	3552.9	83398.2	3006.1	193.5	6522.6	817.7	0.0	0.0	102941.2
8 - 1987	6104.3	3979.2	95073.9	2176.9	138.2	13025.5	654.1	0.0	0.0	121152.1
9 - 1988	6836.8	4456.7	108384.2	1347.6	82.9	7829.9	490.6	0.0	0.0	129428.7
10 - 1989	7657.2	4991.5	123557.9	518.3	27.6	5872.4	327.1	0.0	0.0	142952.1
11 - 1990	8576.1	5590.5	140855.9	0.0	0.0	3915.0	163.5	0.0	0.0	159101.0
12 - 1991	9605.2	6261.4	160575.7	0.0	0.0	1957.5	0.0	0.0	0.0	178399.7

FIGURE 5-15
FIELD AND POWER PLANT DESIGNS, FINANCIAL
OPERATIONAL MARKET PRICE OPERATING EXPENSE REPORT

GLGP CASH FLOW MODEL
OPERATION PERIOD REPORT #P2.6

MARKET PRICE - SINKING FUND ACTIVITY & INVESTMENT REPORT

PROJECT NAME - SAMPLE
PROJECT TYPE - POWER PLANT

FINANCIAL CASE NAME - SAMPLE
FINANCIAL STRUCTURE - TAXABLE ENTITY

5-21

YEAR	STARTING BALANCE +	SINK. FUND DEPOSITS +	SINK. FUND INTEREST	SINK. FUND -INCOME TAXES	SINK. FUND -WITHDRAWALS	FINISHING BALANCE	** SINK. FUND INVESTMENT	OTHER CAP. +INVESTMENT	TOTAL =INVESTMENT
3 - 1982	0.0	4445.9	444.6	225.0	0.0	4665.5	** 0.0	0.0	0.0
4 - 1983	4665.5	4445.9	911.1	461.0	0.0	9561.5	** 0.0	0.0	0.0
5 - 1984	9561.5	4445.9	1400.7	708.8	0.0	14699.4	** 0.0	0.0	0.0
6 - 1985	14699.4	4445.9	1914.5	968.8	0.0	20091.1	** 0.0	0.0	0.0
7 - 1986	20091.1	4445.9	0.1	0.0	24536.4	0.6	** 24536.4	0.0	24536.4
8 - 1987	0.6	0.0	0.1	0.0	0.0	0.7	** 0.0	0.0	0.0
9 - 1988	0.7	0.0	0.1	0.0	0.0	0.7	** 0.0	0.0	0.0
10 - 1989	0.7	0.0	0.1	0.0	0.0	0.7	** 0.0	0.0	0.0
11 - 1990	0.7	0.0	0.1	0.0	0.0	0.8	** 0.0	0.0	0.0
12 - 1991	0.8	0.0	0.1	0.0	0.0	0.8	** 0.0	0.0	0.0

FIGURE 5-16
FIELD AND POWER PLANT DESIGNS, FINANCIAL
OPERATIONAL MARKET PRICE SINKING FUND
ACTIVITY AND INVESTMENT REPORT

GLCP CASH FLOW MODEL
FINANCIAL CASE INPUT DATA DUMP REPORT
FINANCIAL CASE NAME - SAMPLE

VARIABLE# 1 - BASE YEAR
1980

VARIABLE# 2 - POWER-ON-LINE YEAR
1982

VARIABLE# 3 - PROJECT LIFE
12

VARIABLE# 4 - LCAN LIFE
10

VARIABLE# 5 - WORKING CAPITAL - (K\$)
4000.000

VARIABLE# 6 - ELECTRICITY MARKET PRICE - (MILLS/KWH)
140.000

VARIABLE# 7 - FLUID MARKET PRICE - (MILLS/KWH)
70.000

VARIABLE# 8 - CAPACITY FACTOR
CONSTRUCTION PERIOD -
0.0 0.0

OPERATING LIFE -
0.500 0.900 0.900 0.900 0.900 0.900 0.900 0.900 0.900

VARIABLE# 9 - MINIMUM TOTAL EQUITY FRACTION
0.250

VARIABLE# 10 - MINIMUM ANNUAL EQUITY FRACTION
0.100 0.100

VARIABLE# 11 - EQUITY RATE OF RETURN
CONSTRUCTION PERIOD -
0.0 0.0

OPERATING LIFE -
0.300 0.300 0.300 0.300 0.300 0.300 0.300 0.300 0.300

FIGURE 5-17
DATA DUMP FROM FINANCIAL MODULE

GIGP CASH FLOW MODEL
FINANCIAL CASE INPUT DATA DUMP REPORT
FINANCIAL CASE NAME - SAMPLE

VARIABLE# 12 - PRINCIPAL PAYMENTS

CONSTRUCTION PERIOD -
0.0 0.0

OPERATING LIFE -
0.0

0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

VARIABLE# 13 - DEBT INTEREST RATE

CONSTRUCTION PERIOD -
0.180 0.180

OPERATING LIFE -
0.150

0.150 0.150 0.150 0.150 0.150 0.150 0.150 0.150 0.150

VARIABLE# 14 - DCE USER FEE RATE

0.010

VARIABLE# 15 - SINKING FUND DEPOSITS

CONSTRUCTION PERIOD -
0.0 0.0

OPERATING LIFE -
0.0

0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

VARIABLE# 16 - SINKING FUND INTEREST RATES

0.100

VARIABLE# 17 - GENERAL INFLATION RATE

CONSTRUCTION PERIOD -
0.120 0.120

OPERATING LIFE -
0.120

0.120 0.120 0.120 0.120 0.120 0.120 0.120 0.120 0.120

FIGURE 5-17
DATA DUMP REPORT FROM FINANCIAL MODULE
(CONTINUED)

GLSP CASH FLOW MODEL
FINANCIAL CASE INPUT DATA DUMP REPORT

FINANCIAL CASE NAME - SAMPLE

VARIABLE# 18 - ESCALATION RATES FOR CAPITAL COSTS

CAPITAL CATEGORY # 1

CONSTRUCTION PERIOD -

0.160 0.160

OPERATING LIFE -

0.160 0.160 0.160 0.160 0.160 0.160 0.160 0.160 0.160 0.160

CAPITAL CATEGORY # 2

CONSTRUCTION PERIOD -

0.160 0.160

OPERATING LIFE -

0.160 0.160 0.160 0.160 0.160 0.160 0.160 0.160 0.160 0.160

CAPITAL CATEGORY # 3

CONSTRUCTION PERIOD -

0.110 0.110

OPERATING LIFE -

0.110 0.110 0.110 0.110 0.110 0.110 0.110 0.110 0.110 0.110

CAPITAL CATEGORY # 4

CONSTRUCTION PERIOD -

0.110 0.110

OPERATING LIFE -

0.110 0.110 0.110 0.110 0.110 0.110 0.110 0.110 0.110 0.110

CAPITAL CATEGORY # 5

CONSTRUCTION PERIOD -

0.0 0.0

OPERATING LIFE -

0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

VARIABLE# 19 - ESCALATION RATE FOR ELECTRICITY MARKET PRICE

CONSTRUCTION PERIOD -

0.120 0.120

OPERATING LIFE -

0.120 0.120 0.120 0.120 0.120 0.120 0.120 0.120 0.120 0.120

FIGURE 5-17
DATA DUMP REPORT FROM FINANCIAL MODULE
(CONTINUED)

GLGF CASH FLOW MODEL
FINANCIAL CASE INPUT DATA DUMP REPORT

FINANCIAL CASE NAME - SAMPLE

VARIABLE# 20 - ESCALATION RATE FOR FLUID MARKET PRICE
CONSTRUCTION PERIOD -
0.140 0.140

OPERATING LIFE -
0.140 0.140 0.140 0.140 0.140 0.140 0.140 0.140 0.140 0.140

VARIABLE# 21 - ESCALATION RATE FOR O & M COSTS
CONSTRUCTION PERIOD -
0.120 0.120

OPERATING LIFE -
0.120 0.120 0.120 0.120 0.120 0.120 0.120 0.120 0.120 0.120

VARIABLE# 22 - DISCOUNT RATE
CONSTRUCTION PERIOD -
0.160 0.160

OPERATING LIFE -
0.160 0.160 0.160 0.160 0.160 0.160 0.160 0.160 0.160 0.160

VARIABLE# 23 - PROPERTY TAX RATE
CONSTRUCTION PERIOD -
0.020 0.020

OPERATING LIFE -
0.020 0.020 0.020 0.020 0.020 0.020 0.020 0.020 0.020 0.020

VARIABLE# 24 - ROYALTY RATE
CONSTRUCTION PERIOD -
0.050 0.050

OPERATING LIFE -
0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050

VARIABLE# 25 - FEDERAL INCOME TAX RATE
CONSTRUCTION PERIOD -
0.480 0.480

OPERATING LIFE -
0.480 0.480 0.480 0.480 0.480 0.480 0.480 0.480 0.480 0.480

FIGURE 5-17
DATA DUMP REPORT FROM FINANCIAL MODULE
(CONTINUED)

GLGP CASH FLOW MODEL
FINANCIAL CASE INPUT DATA DUMP REPORT
FINANCIAL CASE NAME - SAMPLE

VARIABLE# 26 - STATE INCOME TAX RATE
CONSTRUCTION PERIOD -
0.050 0.050

OPERATING LIFE -	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
------------------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

VARIABLE# 27 - INVESTMENT TAX CREDIT RATES

CAPITAL CATEGORY # 1
CONSTRUCTION PERIOD -
0.200 0.200

OPERATING LIFE -	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
------------------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

CAPITAL CATEGORY # 2
CONSTRUCTION PERIOD -
0.200 0.200

OPERATING LIFE -	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
------------------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

CAPITAL CATEGORY # 3
CONSTRUCTION PERIOD -
0.140 0.140

OPERATING LIFE -	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140
------------------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

CAPITAL CATEGORY # 4
CONSTRUCTION PERIOD -
0.140 0.140

OPERATING LIFE -	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140
------------------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

CAPITAL CATEGORY # 5
CONSTRUCTION PERIOD -
0.0 0.0

OPERATING LIFE -	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
------------------	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

FIGURE 5-17
DATA DUMP REPORT FROM FINANCIAL MODULE
(CONTINUED)

CLGP CASH FLOW MODEL
FINANCIAL CASE INPUT DATA DUMP REPORT
FINANCIAL CASE NAME - SAMPLE

VARIABLE# 28 - DEPLETION ALLOWANCE RATE
CONSTRUCTION PERIOD -
0.150 0.150

OPERATING LIFE -
0.150 0.150 0.150 0.150 0.150 0.150 0.150 0.150 0.150

5-27

FIGURE 5-17
DATA DUMP REPORT FROM FINANCIAL MODULE
(CONCLUDED)

REFERENCES

Grupta, J.N., and J.G. Leigh, "GELCOM-A Geothermal Levelized Busbar Cost Model: Description and User's Guide," Report M78-17, The MITRE Corporation, McLean, Virginia, 1978.

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APPENDIX A

GCFM FINANCIAL ANALYSIS EQUATIONS

GCFM FINANCIAL ANALYSIS EQUATIONS

This appendix documents the major calculational approaches used in the Geothermal Loan Guaranty Cash Flow Model financial routines.

The subjects covered are:

I. Annual Accounts

- Ia. Annual Revenue
- Ib. Annual Operating Expenses
- Ic. Annual Taxable Income
- Id. Annual After Tax Income
- Ie. Annual Cash Flows

II. Breakeven Prices

- IIa. Annual Breakeven Price
- IIb. Levelized Breakeven Price

III. Discounted Cash Flow Rate of Return

IV. Sinking Fund Calculations

V. Salvage Value

Ia Annual Revenue

$$(A-1) \quad R_i = P_i C_i Q (0.36525) (24) + S_i$$

Where:

i = the year

P_i = annual sales price (mills/kwh)*

C_i = annual capacity factor

Q = sales output (MW_e),**

S_i = annual salvage revenue,

R_i = total revenue

*The annual sales price for the market price calculations is determined using the base year market price and a market price escalation factor. The annual prices in the breakeven price case are derived by reviewing the entire cash flow calculation.

**The factor (.36525) (24) converts MWe into 10³ KWh.

Ib Annual Operating Expenses

$$(A-2) \quad OC_1 = OM_1 + F_1 + PT_1 + IDC_1 + DF_1 + INT_1 + ROY_1 + DPR_1 + DPL_1$$

where:

OM_1 = sum of the annual overhead and maintenance costs, and the other operating costs

F_1 = annual fuel cost,*

P_1 = annual property tax assessment,

IDC_1 = sum of the annual intangible drilling costs and the annual dry hole expenses,

DF_1 = annual DOE user fee,

INT_1 = annual interest costs,

ROY_1 = annual royalty paid for the leaseholder,

DPR_1 = annual tax depreciation,**

DPL_1 = annual depletion allowance, and

OC_1 = total annual operating expenses.

*The cost of fuel refers to either the power plant fluid costs or the field's electricity costs.

**Tax depreciation is accelerated using the sum of the years digits method.

Ic Annual Taxable Income

$$(A-3) \quad TXI_i = R_i - OC_i$$

where:

R_i = annual revenue

OC_i = annual operating expense,

TXI_i = annual taxable income

If the resulting value TXI_i from equation (A-3) is greater than 0, the model determines whether or not unused tax losses exist. If they do, they are carried forward to year i such that the result

$$(A-4) \quad TXI_i - TLF_i \geq 0$$

where:

TLF_i - tax loss forward in year i

TXI_i - taxable income,*

The taxable income is then restated to reflect the loss carry forward as follows:

* Note if the TXI_i values is negative the value is placed in the unused tax loss account.

$$(A-5) \quad TXI_i = R_i - OC_i - TLF_i \geq 0$$

Id Annual After Tax Income

If equation I^c produces a TXI_1 , which is greater than zero the model calculates a tax liability.

$$(A-6) \quad ATI_1 = TXI_1 (1 - ET_1) + TC_1$$

Where:

TXI_1 = annual taxable income

ET_1 = effective tax rate,

TC_1 = annual investment tax credit,

ATI_1 = annual after tax income.

Ie Annual Cash Flows

$$(A-7) \quad CF_1 = ATI_1 + DPR_1 + IDC_1 + TCF_1 - PMT_1 - INV_1 - SFD_1$$

Where:

ATI_1 = annual after tax income

DPR_1 = annual tax depreciation,

IDC_1 = sum of the annual intangible drilling costs and the annual other operating costs.

TLF_1 = annual tax loss carried forward

PMT_1 = annual debt retirement payment (principle only),

INV_1 = annual non sinking fund investment,

SFD_1 = annual sinking fund deposit,

CF_1 = annual net cash flow.

IIa Annual Breakeven Price

The annual breakeven price in each year is defined as that price which will cover all operating expenses and yield a desired after tax return on equity. The model calculates a breakeven cash flow which equals the equity value of the project multiplied by the equity rate of return. This annual breakeven cash flow is the after tax return from which each annual breakeven price is calculated.

Before making these calculations, we first define the initial equity value at the power-on-line date as the total capital cost minus the amount of debt financing. The subsequent annual equity values are calculated as follows:

$$(A-8) \quad E_1 = E_{1-1} - BDP_1 + INV_1 + PMT_1$$

Where:

E_1 = equity value

BDP_1 = book depreciation

INV_1 = capital investments (replacements)

PMT_1 = debt retirement payments (principal only)

The derivation of Equation (A-8) is as follows. The total capital value is the sum of the debt and equity values. From this we obtain Equation A-9.

$$(A-9) \quad C_i = D_i + E_i$$

The annual change in capital value of the project is determined by depreciation and investments. This yields Equation A-10.

$$(A-10) \quad C_i = C_{i-1} - BDP_i + INV_i$$

The annual change in the outstanding debt is determined by the annual debt repayment. This yields Equation A-11.

$$(A-11) \quad D_i = D_{i-1} - PMT_i$$

The combination of Equations A-9 and A-10 yields Equation A-12.

$$(A-12) \quad D_i + E_i = D_{i-1} + E_{i-1} - BDP_i + INV_i$$

Combining Equations A-11 and A-12 yields Equation A-13

$$(A-13) \quad D_i + E_i = D_i + PMT_i + E_{i-1} - BDP_i + INV_i$$

or

$$E_i = E_{i-1} - BDP_i + INV_i + PMT_i$$

Which is the same as Equation A-5.

Building upon this definition of equity, we can then derive the breakeven cash flow and the rate of return in equity as follows:

$$(A-14) \quad BCF_1 = E_1 (ROR_e)$$

Where:

BCF_1 = breakeven cash flow in year 1

ROR_e = rate of return on equity desired

Finally, drawing from Equation A-2, A-7 and A-14, and consolidating variables, the annual breakeven price is calculated as follows:

$$(A-15) \quad ABP_1 = BCF_1 + NTD_1 - OPE_1 - S_1$$

Where:

ABP_1 = annual breakeven price

NTD_1 = non-cash tax deductions [(intangible drilling costs; (IDC₁) tax loss carried forward (TLF₁), and annual tax depreciation, (DPRI₁)]

OPE = out-of-pocket expenses except interest on debt [(total annual operating expenses (OC₁), Taxes paid (TX₁), debt retirement payment (PMT₁), and sinking fund deposit (SFD₁)]

S_1 = annual salvage value

IIb Levelized Breakeven Price

As discussed previously, GCFM solves for two distinct levelized breakeven prices. Figure A-1 presents a comparison of the two levelized breakeven prices with the annual breakeven price solved for in Equation A-15 above. All solid lines in this figure represent nominal or current dollar values. BP_1 is the levelized price adopted by EPRI (EPRI, 1979) and commonly used by the electric utility industry. It appears in Figure A-1 as a horizontal line which bisects the upward sloping annual breakeven price. By definition, the sum of the present worth of the levelized price stream, BP_1 , must be equal to the present worth of the annual breakeven price stream. Mathematically, this is expressed as:

$$(A-16) \quad \begin{array}{l} \text{Net Present Value} \\ \text{of Revenue Stream} \end{array} = \sum_{i=1}^N \frac{P_i \cdot Q_i}{(1+a)^{i-1}} = \sum_{i=1}^N \frac{BP_1 \cdot Q_i}{(1+a)^{i-1}}$$

Where:

P_i = annual breakeven price

Q_i = annual output (on 10^3 KWh)

a = discount rate

BP_1 = levelized breakeven price (in current dollars)

For the early years of a project (up to the point where the annual breakeven price line crosses BP_1), the current dollar price of BP_1 will be greater than the actual breakeven price required in those years. During the later years, however, the price of BP_1 will be lower than the annual breakeven price. Implicit within the definition of BP_1 is that the constant dollar value of its revenue stream will decline over time.

**FIGURE A-1
BREAKEVEN PRICES**

An alternative way of expressing levelized cost is to develop a smooth curve that approximates the irregular slope of the annual breakeven price curve. For this reason, BP_2 has been developed and used for comparative purposes (MITRE, 1977 and MITRE, 1978) to express a levelized price which escalates at fixed rate but is expressed in constant rather than current dollars. The mathematical expression for this approach is as follows:

$$(A-17) \quad \begin{array}{l} \text{Net Present Value} \\ \text{of Revenue Stream} \end{array} = \sum_{i=1}^N \frac{P_i \cdot g_i}{(1+a)^{i-1}} = \sum_{i=1}^N \frac{BP_2 \cdot g_i (1+e)^{i-1}}{(1+a)^{i-1}}$$

e = real energy price escalation rate

BP_2 = levelized breakeven price (in constant dollars)

Implicit within BP_2 is the assumption that real energy prices will rise at some unspecified annual escalation rate, C , which the model user may select.

Although BP_1 is always greater than BP_2 , the differences are entirely conceptual and interpretive in nature.

Despite the different approaches, both methods would result in exactly the same ordering of projects by economic preference. There are philosophical arguments which can be made for using each levelizing technique, depending upon one's frame of reference and the desired assumptions about future price escalations. For the purposes of this model, both levelized prices are provided to enable the user to determine his own preferred approach.

III DCFROR

To aid in the comparison of various cases both the market price calculations and the breakeven price calculations include calculations at discounted cash flow rates of return (DCFROR). Mathematically, this is the same technique for calculating an internal rate of return (IRR), in which the rate of return solved for is the one which makes the net present value of the project equal to zero. Two such calculations are performed by the model.

DCFROR is a strict textbook calculation. The cash flows are to be discounted at unknown rate r such the resulting present value of the cash flow stream is zero. Equation A-18 represents this calculation.

$$(A-18) \quad 0 = \sum_{i=1}^N CF_i \frac{1}{(1 + R_1)^{i-1}}$$

where

i = the year

CF_i = annual cash flow

R_1 = DCFROR₁

This represents a nominal (including inflation) rate of return.

DCFROR₂ is a discounted cash flow calculation for the incremental rate of return above a minimum acceptable rate, say the historical average return on investment. This calculation method is similar to that of the DCFROR₁, except that the cash flows are discounted twice; first by a typical discount rate which incorporates a real

average return on investment (say 2-3 percent) plus inflation;
and second, by the incremental rate (R_2) which, when solved for,
represents the additional return above an assumed average return
earned on venture capital. Equation A-19 represents this calculation.

$$(A-19) \quad 0 = \sum_{i=1}^N \left(\frac{CF_i}{(1+a)^{i-1}} \right) \left(\frac{1}{(1+R_2)^{i-1}} \right)$$

Where:

CF_i = annual cash flow

a = discount rate accounting for the time value of money
for an average or minimally acceptable investment,
including inflation

R_2 = DCFROR₂ or incremental rate of return

In the event that a stream of cash flows cannot be discounted
to zero. The model will not return a rate of return. Such a stream
might look like this:

The stream must at least cross the +\$/-\$ axis to have a finite rate of return.

IV Sinking Fund Calculations

The sinking fund operations are made in the following order:

- 1) Deposits made and investments removed
- 2) Interest calculated
- 3) Taxes calculated
- 4) Year end balance recalculated to reflect interest and taxes.

$$(A-20) \quad SF_1 = SF_{1-1} + SD_1 = SW_1$$

$$(A-21) \quad SI_1 = SF_1 \cdot SFR$$

Recalculate year end balance

$$(A-22) \quad SF_1 = SF_{1-1} + SD_1 - SW_1 + SI_1 - ST_1^4$$

Where:

SF_1 = year end sinking fund balance,

SD_1 = annual interest earned on sinking fund,

SW_1 = annual sinking fund withdrawal,

SI_i = annual interest earned on sinking fund,

ST_i = annual income tax paid on sinking fund interest income

ET_i = annual affective income tax rate,

SFR = sinking fund interest rate.

The Sinking Fund Deposits default calculates a deposit amount sufficient to cover future capital investments associated with equipment replacement. A factor is used to calculate these deposits as a fraction of the replacement cost of an asset.

$$(A-23) \quad \frac{SFR(1-ATX)}{FTR [(SFR(1-ATX) + 1)^{LF} - 1]}$$

Where:

ATX is the Average Effective income tax rate

SFR is the sinking fund interest rate

LF is the life of the asset,

and FTR is the sinking fund deposit factor.

V. SALVAGE VALUE

When equipment is expected to have salvage value at the end of its book life, the model will account for this as income. The salvage value should be entered, for the appropriate capital account, as a percentage of the capital cost of all the items in that account.

The model does not contain explicit provision for any salvage value remaining in a capital account (due to unused book life of equipment) at the end of the life of the plant. If such salvage value is expected, it should be estimated manually, and entered in the last year of plant life as a negative value for "Other Operating Costs."

Table A-1 illustrates how GCFM treats salvage values.

TABLE A-1

TREATMENT OF SALVAGE VALUES

Asset: Pump Salvage 10% Escalation Rate 10%
 Life: 5 years Tax Credits 10%
 Cost: 500K Asset Depreciation Basis = $500 - 50 = 450$

	Year	Investment	Book Dep	Tax Dep	Salvage	Tax Cr Avail.	
Construction Period	1						
	2						
	3	500K					
	4		90	150		50	ORIGINAL PUMP
	5		90	120			
Operating Life	6		90	90			
	7		90	60			
	8	805	90	30			
	9		144.8	241.3	50	81	REPLACEMENT PUMP
	10		144.8	193.1			
	11		144.8	144.8			
	12		144.8	96.5			
	13	1296.9	144.8	48.3			
	14		259.4	432.3	81	130	
	15		259.4	345.8			
Last Year	16		259.4	259.4			
	17		259.4	172.9			
	18		259.4	86.5			

No replacement made in last year. 130 REPLACEMENT PUMP

Salvage would not be taken

APPENDIX B

POWER PLANT CYCLE DESIGN
AND COSTING ROUTINES

POWER PLANT CYCLE DESIGN AND COSTING ROUTINES

GCFM contains subroutines that estimate brine flow requirements, equipment sizes, and capital and overhead and maintenance costs for geothermal electric power plants. These routines are part of the Power Plant Module. They are described in this appendix to give GCFM users a basic understanding of what they do. Detailed understanding requires an engineering background, and examination of the Fortran code for the routines.

The purpose of these routines is to:

(1) Provide estimates of the brine flow requirements for a plant of specified size and fluid inlet temperature. This brine flow requirement is needed to size a field development project, if the field development project is not accompanied by a conceptual or detailed design for the power plant.

(2) Provide rough checks for power plant cost estimates included in loan guaranty applications. Detailed analyses of power plant project cash flows will ordinarily be based on detailed plant designs submitted by the applicant.

The reader should note that the technical and cost estimates calculated by these routines are first-order and non-optimized.

The estimates are based on generic and simplified approaches to power plant design and costing. The results should not be construed as definitive for actual projects.

The routines handle four different types of power plant designs: (1) Dry (Superheated) Steam, (2) Single-Stage Flash, (3) Dual-Stage Flash, and (4) Isobutane-Binary Cycle, as selected by the user. The process estimates for the first three designs are calculated by subroutine STDES; costs for these designs are estimated by subroutine STCST. For the binary design, the corresponding subroutines are labelled BTDES and BTCST.

Figures B-1 through B-4 show the schematic designs used for the four types of plants. In these diagrams, T = Temperature, P = Pressure, H = Enthalpy, and S = Entropy.

Dry Steam Design (Figure B-1): Steam enters the turbine directly and exhausts into a barometric condensor. The condensate is circulated to an elevated cooling tower (wet tower shown, dry tower to be selected). The cooling water flows back to the condenser sprays due to gravity head and condenser vacuum. Excess condensate is reinjected.

Single-Stage Flash Design (Figure B-2): The brine entering the plant is flashed to saturated steam. If the user has not specified the flash tank exit temperature, T_2 , the code assumes:

$$T_2 = \sqrt{T_1 * T_4}$$

The brine from the flash tank is reinjected without further treatment. The remainder of the cycle is identical to that for dry steam plant. Excess condensate is boosted from P_5 To P_2 by a small pump and then reinjected by the main reinjection pump.

B-5

FIGURE B-1
GEOTHERMAL DRY STEAM SCHEMATIC

B-6

FIGURE B-2
GEOTHERMAL SINGLE FLASH SCHEMATIC

FIGURE B-3
GEOHERMAL DUAL STAGE FLASH SCHEMATIC

FIGURE B-4
GEOTHERMAL BRINE/BINARY SCHEMATIC

Dual-Stage Flash Design (Figure B-3): This design is identical to the single-stage flash design, except that dual flashing and a two-stage turbine are used to extract slightly more energy from the brine. If T_2 or T_3 are not specified by the user, they are assumed to be:

$$T_2 = \sqrt[3]{T_1 * T_1 * T_4}$$

$$T_3 = \sqrt{T_2 * T_4}$$

Binary Design (Figure B-4): This design is based on the transfer of heat from the geothermal brine to isobutane, the turbine working fluid. The code is a special case of a binary cycle that is applicable only to supercritical isobutane thermodynamic cycles.

The geothermal brine enters the primary heat exchanger at T_6 and P_6 . If the turbine inlet temperature, T_1 , is not entered explicitly, it defaults to 373°F. This is correct for brine temperatures, T_6 , of 400°F or higher. If you enter a brine temperature less than 400°F, then you must enter a turbine inlet temperature. In that case, if you do not take the turbine inlet temperature from an explicit design, you should make the turbine inlet temperature 30°F less than the brine inlet temperature.

Both the primary heat exchanger and the condenser are of shell and tube design, with the isobutane always on the shell side. Again, as in all these designs, the cooling tower may be of wet or dry design.

The water/steam and isobutane properties estimated by these functions all fall within one percent of the sources from which they were derived. The water/steam properties were derived from data in Table 3-276 and Table 3-277 of R.H. Perry and C.H. Chilton, Chemical Engineer's Handbook, 5th Edition, Mc-Graw-Hill, 1973. The isobutane properties were derived from Table 29, ASHRAE Handbook of Fundamentals American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., New York, 1972, and Compressor Handbook, Elliott Division of Carrier Corporation, Jeannette, Pennsylvania, 1965.

The costing functions were taken from the GEOCOST model of geothermal electric plants, prepared by the Battelle Pacific Northwest Laboratories.

Data Input Sheets: The input requirements vary slightly for each of the four plant designs. To facilitate the data input process, a design input sheet has been prepared. This sheet, in conjunction with the cycle design data dump, serves as a useful record of the assumptions used in each analysis.

Sequence of Costing Calculations: The two cycle design and costing subprograms (steam and binary) each perform three steps when calculating the cycle and costing the plant. These steps are:

Step 1 - Given the design input parameters the program calls the appropriate thermodynamic functions, calculating temperatures, pressures, enthalpy, and entropy values, and specific volume as needed by the design. The four design types each require different input data.

You should note that none of the designs make explicit provision for required make-up water for the cooling tower. At sites where much surface water is needed for make up, you will have to treat this as an additional operation expense.

The cycle design routines use MITRE-derived functions for the thermodynamic properties of water and isobutane. The functions were derived to be computationally rapid rather than extremely accurate.

Step 2 - After all the design points have been determined and any required intermediate thermodynamic values have been calculated, the program calculates a first-order turbine size, based on the generator efficiency and the desired net output, but omitting consideration of power needed to run auxiliary equipment (pumps, etc.). The cycle calculation routine then enters a 2-pass iterated loop to estimate the power required for auxiliary equipment and to increase the size of the turbine and generator to provide the required auxiliary power. The logic of Step 2 is described by the flowcharts in Figure 5 and Figure 6.

Sept 3 - After completion of the two step iteration, the cycle calculation routine enters one of two cost calculation routines (steam or binary).

Local Wet Bulb Temperatures: The local 95 percent wet bulb temperature, traditionally used as the heat reinjection design temperature, varies from region to region. Table B-1 gives the 95 percent wet bulb temperature for many of the significant U.S. geothermal prospects. This table was prepared by Mr. T.W. Lawford of EG&G Idaho Falls (personal communication, 1980).

FIGURE B-5
FLOWCHART OF STEAM CYCLE CALCULATION ROUTINE

FIGURE B-6
FLOWCHART OF BINARY CYCLE CALCULATION ROUTINE

TABLE B-1

GEOTHERMAL AREA WET BULB TEMPERATURES
(Location Numbers Correspond to those Listed in USGS Circ. 790)

<u>ARIZONA</u>		
<u>Name of Area</u>	<u>Location No.</u>	<u>TWB (°F)</u>
Power Ranches Inc., Wells	029	75
Eagle Creek	030	67
North of Clifton	031	67
Gillard Hot Springs	032	67
San Simon Well	033	66
 <u>CALIFORNIA</u>		
Lassen	040	61
The Geysers	048	65
Surprise Valley Area	035	63
Morgan Springs-Growler Springs	041	61
Sulphur Bank Mine (Hot Bolata)	046	67
Clear Lake Volcanic Field Area	047	67
Long Valley Caldera	056	59
Coso Area	057	71
Randsburg Area	058	71
Salton Sea Area	064	79
Westmorland	064A	79
Brawley	065	79
East Mesa	068	79
Border	070	79
Heber	071	79
Fort Bidwell Area	034	63
West Valley Reservoir Hot Spring	036	63
Bassett Hot Spring	037	62
Kelly Hot Spring	038	63
Big Bend Hot Springs	039	61
Wendel-Amadee Area	042	60
Sierra Valley Area	043	61
Wilbur Springs Area	044	67
Chalk Mountain Area	045	67
Skaggs Hot Springs	049	67
Calistoga Hot Springs	050	67

TABLE B-1

GEOTHERMAL AREA WET BULB TEMPERATURES
(Location Numbers Correspond to those Listed in USGS Circ. 790)
(Continued)

<u>CALIFORNIA</u> (Continued)		
	<u>Location No.</u>	<u>TWB (°F)</u>
Grovers Hot Springs	051	60
Fales Hot Springs	052	59
Buckeye Hot Spring	053	59
Travertine Hot Springs Area	054	59
North Shore Mono Lake (Black Rock Point Hot Spring)	055	59
Tecopa Hot Springs	059	70
Scovern Hot Springs	060	70
Sespe Hot Springs	061	66
Arrowhead Hot Springs	062	72
Pilger Estates Hot Springs	063	79
Glamis (East Brawley)	066	79
Glamis East	067	79
Dunes	069	79
 <u>COLORADO</u>		
Paradise Hot Spring	078	62
Routt Hot Springs	072	61
Penny (Avalanche) Hot Springs	073	62
Mt. Princeton Hot Springs Area	074	54
Poncha Hot Springs	075	54
Waumita Hot Springs	076	55
Cebolla (Powderhorn) Hot Springs	077	57
Wagon Wheel Gap	079	57
San Dunes Swimming Pool Well	080	61
Mapco State Well 1-32	081	61
Splashland Hot Water Well	082	61
 <u>IDAHO</u>		
Crane Creek-Cove Creek Area	093	64
Big Creek Hot Springs	105	63
Red River Hot Springs	086	62
Riggins Hot Springs	087	63
Krigbaum Hot Springs	088	63

TABLE B-1
GEOTHERMAL AREA WET BULB TEMPERATURES
(Continued)

<u>IDAHO (Continued)</u>		
<u>Name of Area</u>	<u>Location No.</u>	<u>TWB (°F)</u>
White Licks Hot Springs	090	64
Vulcan Hot Springs	090	64
Cabarton Hot Springs	091	64
Boiling Springs	092	64
Weiser Area	094	64
Roystone Hot Springs	095	64
Bonneville Hot Springs	096	64
Payette River Area Near Banks	097	64
Neinmeyer Hot Springs	098	64
Latty Hot Springs	099	64
Radio Towers Area	100	64
Gravel Pits Area	101	64
Bruneau-Grand View Area	102	64
Murphy Hot Springs	103	62
Owl Creek Hot Springs	104	63
Sharkey Hot Springs	106	63
Sunbeam Hot Springs	107	64
Slate Creek Hot Springs	108	64
Magic Reservoir Area	109	64
Worswick (Wasewick) Hot Spring	110	64
Wardrop Hot Springs	111	64
Barron's Hot Springs	112	64
White Arrow Hot Springs	113	64
Banbury Area	114	64
Raft River Area	115	63
Ashton Warm Springs	116	61
Newdale Area	117	61
Maple Grove Hot Springs	118	63
Riverdale Area (Ben Meek Well)	119	63
Wayland (Battle Creek) Hot Springs	120	63
Squaw Hot Springs Area	121	63
<u>MONTANA</u>		
Marysville Test Well	122	61
Broadwater (Helena) Hot Spring	123	61
Alhambra Hot Springs	124	61
Boulder Hot Springs	125	59

TABLE B-1
GEOTHERMAL AREA WET BULB TEMPERATURES
(Continued)

<u>MONTANA</u> (Continued)		
<u>Name of Area</u>	<u>Location No.</u>	<u>TWB (^oF)</u>
Gregson (Fairmont) Hot Springs	126	58
Norris (Hapgood, Beartrap) Hot Springs	127	58
Silver Star (Barkel's) Hot Springs	128	58
Ennis (Thexton) Hot Springs	129	59
<u>NEVADA</u>		
Baltazor Hot Springs	130	57
Pinto Hot Springs	132	57
Great Boiling Springs (Gerlach)	137	58
San Emedio Desert Area	138	58
Steamboat Springs	141	61
Lee Hot Springs	143	61
Soda Lake Area	144	61
Stillwater Area	145	61
Fernley Area	146	61
Brady Hot Springs	147	61
Desert Peak Area	148	61
Humboldt House	151	58
Kyle Hot Springs	152	59
Leach Hot Springs	154	61
Beowawe Hot Springs	162	61
Hot Sulphur Springs (Tuscarora)	164	61
Sulphur Hot Springs (Hot Sulphur Springs)	169	57
Dyke Hot Springs	131	57
Double Hot Springs Area	133	58
Black Rock Point Area	134	58
Butte Springs (Trego)	135	58
Fly Ranch (Wards) Hot Springs	136	58
The Needles (Needle Rocks, Pyramid Lake)	139	60
Moana Area	140	61
Wabuska Hot Springs	142	61
Dixie Hot Springs	149	60

TABLE B-1
GEOTHERMAL AREA WET BULB TEMPERATURES
(Continued)

<u>NEVADA (Continued)</u>		
<u>Name of Area</u>	<u>Location No.</u>	<u>TWB (°F)</u>
Colado Area	150	62
Sou (Gilbert's) Hot Springs	153	60
Golconda Hot Springs	155	61
Hot Pot (Blossom Hot Springs)	156	61
Hot Springs Ranch	157	61
Buffalo Valley Hot Springs	158	60
Smith Creek Valley Area	159	60
Spencer Hot Springs	160	60
Darrough Hot Springs	161	60
Hot Springs Point	163	61
Carlin Area	165	61
Hot Hole (Elko Hot Springs)	166	61
Mineral (San Jacinto Hot Springs)	167	62
Hot Sulphur Springs (Sulphur Springs)	168	61
Cherry Creek Area	170	62
<u>NEW MEXICO</u>		
Valles Caldera	171	62
Jemez Springs (Ojos Calientes)	172	62
Spence Spring	173	62
San Francisco (Lower Frisco) Hot Springs	174	67
Radium Hot Springs	175	68
Lightning Dock Area	176	66
<u>OREGON</u>		
Newberry Caldera	184	60
Crump's Hot Springs	190	62
Mickey Hot Springs	196	62
Alvord Hot Springs	197	62
Hot (Borax) Lake Area	198	62
Trout Creek Area	199	62
Neal Hot Springs	203	64

TABLE B-1
GEOHERMAL AREA WET BULB TEMPERATURES
(Continued)

<u>OREGON (Continued)</u>		
<u>Name of Area</u>	<u>Location No.</u>	<u>TWB (°F)</u>
Vale HotSprings	204	64
Mount Hood Area	177	60
Carey (Austin) Hot Springs	178	60
Breitenbush Hot Springs	179	60
Kahneetah Hot Springs	180	60
Belknap Hot Springs	181	62
Foley Hot Springs	182	62
McCredie (Winino) Hot Springs	183	63
Umpqua Hot Springs	185	63
Klamath Hills Area	186	61
Klamath Falls Area	187	61
Summer Lake Hot Springs	188	62
Lakeview Area (Hunters and Barry Ranch Hot Springs)	189	62
Fisher Hot Springs	191	62
Weberg Hot Springs	192	63
Harney Lake Area	193	62
Crane Hot Springs	194	62
Riverside Area	195	63
McDermitt Area	200	61
Medical Hot Springs	201	63
Little Valley Area	202	64
<u>UTAH</u>		
Cove Fort-Sulphurdale	208	62
Rossevelt Hot Spring (McKeans)	209	62
Abraham (Baker, Crater(Hot Springs)	205	63
Monroe-Red Hill Hot Springs	206	62
Joseph Hot Springs	207	62
Thermo Hot Springs	210	62
Newcastle Area	211	62

TABLE B-1

GEOTHERMAL AREA WET BULB TEMPERATURES
(Concluded)

<u>WASHINGTON</u>		
<u>Name of Area</u>	<u>Location No.</u>	<u>TWB (°F)</u>
Gamms Hot Springs	213	58
Baker Hot Springs	212	58
Ohanapecosh Hot Springs	214	58
<u>WYOMING</u>		
Mud Volcano Area	215A	60
Yellowstone Caldera Area	215	60
Huckleberry Hot Springs	216	60
Granite Hot Springs	217	61
Auburn Hot Springs	218	61

DATA RECORD SHEETS

GLGP Cash Flow Model
Data Record Sheet - CYCLE DESIGN

CASE NAME: _____

RUN DATE: _____ RUN TIME: _____ RUN NUMBER: _____

	DRY	SINGLE	DOUBLE	BRINE	
	STEAM	FLASH	FLASH	EINARY	DEFAULT
Well Head Temp.					400.0
Well Head Pres.					Calc.
Brine Injection Temp.					Calc.
Brine Injection Pres.					Calc.
Gas Content (%)					1.0
Disolved Solids (PPM)					14000
Net Sales Output (MWE)					50.0
Generator Efficiency (%)					82.5
Turbine Efficiency (%)					75.0
Turbine Efficiency - L.P.					75.0
Flash Tank Temp.					Calc.
Flash Tank Temp. - L.P.					Calc.
W.F. Temp. - Turb. Inlet					373.0
W.F. Pres. - Turb. Inlet					1600.0
W.F. Pres. - Turb. Outlet					70.0
Turbine Outlet Temp.					125.0
Cooling Water Temp.					90.0
Condenser Outlet Temp.					115.0
Design Wet Bulb Temp					79.0
Height of Cooling Tower					40.0
Pump & Piping Material					1 (CS)
Pump Driver Type					1 (motor)
Cooling Tower Type					1 (wet)
Cooling Tower Material					1 (wood)

GLGP Cash Flow Model
Data Record Sheet - POWER PLANT DESIGN

CASE NAME: _____

RUN DATE: _____ RUN TIME: _____ RUN NUMBER: _____

GENERAL DATA				DEFAULT	
1	Base Year				1979
2	Plant Cost Index				100.0
3	Project Life				
4	Power-on-Line Year				
5	Net Sales Output (MWE)				0.0
6	Turbine Rating (MWE)				Calculated
7	Brine Flow Req. (KLB/HR)				Calculated
		8 - Capital	9 - Book	10 - Tax	
CAPITAL ACCOUNTS		Cost* (K\$)	Life**	Life***	
	#1				
	#2				
	#3				
	#4				
	#5				
		11 - Salvage	12 - O&M		
CAPITAL ACCOUNTS		Rate****	Rate****		
	#1				
	#2				
	#3				
	#4				
	#5				
	Range #	Value	Rate	FY	LY
13	Other #1				
	Operating #2				
	Costs (K\$) #3				
14	Sunk Costs (K\$)				0.0
15	Construction #1	#2	#3	Calculated	
	Investment #4	#5	#6		
	Breakdown #7	#8	#9		

- * Capital Cost Defaults Calculated
 ** Book Life Defaults - 20/5/12/30/30
 *** Tax Life Defaults - 20/5/12/30/30
 **** Salvage Rates and O&M Rates, Default to zero

GLGP Cash Flow Model
Data Record Sheet - FIELD DESIGN (Sheet 1 of 2)

CASE NAME: _____

RUN DATE: _____ RUN TIME: _____ RUN NUMBER: _____

GENERAL DATA				DEFAULT
1	Base Year			1979
2	Plant Cost Index			100.0
3	Project Life			
4	Power-On-Line Year			
5	Plant Type			1 (Steam)
6	Field Output (MWE)			0.0
7	Field Elect. Con. (MWE)			Calculated
8	Brine Flow Req. (KLB/HR)			0.0
RESERVOIR DATA				
9	Depth (FT)*			0.0
10	Salinity (PPt)*			0.0
11	Rock Type (1,2,3)*			1 (Soft)
12	Temperature (F°)*			0.0
WELL DATA		PROD**	INJ**	DPW**
13	Well Flow Rates (KLB/HR)			Calculated
14	Cost of Wells*** (K\$)			Calculated
15	Cost Per DWP** (K\$)			250
16	DWP Switch (1,2,3)			2
17	Book Lives			10/10/5
18	Tax Lives			6/6/5
19	Salvage Rates			0.0
20	O&M Rates			0.0
21	IDC Rates****			0.0

- * Values may be required for calculated default values
 ** PROD - Production Wells, INJ - Injection Wells and DWP - Downwell Pumps
 *** Input Routine - Enter Cost Per Well
 Change Routine - Enter Total Cost of Wells
 **** IDC - Intangible Drilling Costs

GLGP Cash Flow Model
Data Record Sheet - FIELD DESIGN (Sheet 2 of 2)

CASE NAME: _____

RUN DATE: _____ RUN TIME: _____ RUN NUMBER: _____

WELL DATA (continued)					DEFAULT
Range #	Value	Rate	FY	LY	
22 Drilling #1					1.0 for all years
Success Ratio #2					
#3					
23 Cost per Makeup Well					0.0
Range #	Value	Rate	FY	LY	
24 Number of Makeup #1					0.0 for all years
Wells #2					
#3					
FIELD PLANT DATA		ACCT. #4	ACCT. #5		DEFAULT
25 Field Plant Cap. (K\$)					Calculated
26 Book Lives					20/30
27 Tax Lives					20/12
28 Salvage Rates					0.0
29 O&M Rates					0.0
OTHER DATA					
30 Field Exploration Cost					0.0
Range #	Value	Rate	FY	LY	
31 Other Operating #1					0.0 for all years
Costs (K\$) #2					
#3					
32 Sunk Costs (K\$)					0.0
33 Construction	#1	#2	#3		Calculated
Investment	#4	#5	#6		
Breakdown	#7	#8	#9		

GLGP Cash Flow Model
Data Record Sheet - FINANCIAL INPUT (Sheet 1 of 2)

CASE NAME: _____

RUN DATE: _____ RUN TIME: _____ RUN NUMBER: _____

					DEFAULT
1	Base Year				1979
2	Power-on-Line Year				
3	Project Life				
4	Loan Life				
5	Working Capital (K\$)				0.0
6	Elect. Price (Mills/kwh)				50.0
7	Fluid Price (Mills/kwh)				20.0
	Range #	Value	Rate	FY	LY
8	Capacity #1				0.0-Con.
	Factor #2				0.8-Oper.
9	Minimum Equity Fraction				.25
10	Construction #1		#2	#3	0.0 for
	Investment Annual #4		#5	#6	all years
	Equity Fractions #7		#8	#9	
	Range #	Value	Rate	FY	LY
11	Equity Rate of #1				0.0 for
	Return #2				all years
12	Payments on #1				Calculated
	Debt #2				
13	Debt Interest #1				0.0 for
	Rate #2				all years
14	DOE Fee Rate				.01
	Range #	Value	Rate	FY	LY
15	Sinking Fund #1				Calculated
	Deposits #2				
16	Sinking Fund Int. Rate				0.0

GLGP Cash Flow Model
Data Record Sheet - FINANCIAL INPUT (Sheet 2 of 2)

CASE NAME: _____

RUN DATE: _____ RUN TIME: _____ RUN NUMBER: _____

	Range #	Value	Rate	FY	LY	Default
17	General #1					0.0 for
	Inflation Rate #2					all years
18	Escalation #					0.0 for
	Rate for #					all
	Capital Costs #					years
	#					
	#					
	#					
19	Escalation Rate #1					0.0 for
	Electricity Price #2					all years
20	Escalation Rate #1					0.0 for
	Fluid Price #2					all years
21	Escalation Rate #1					0.0 for
	O&M Costs #2					all years
22	Discount Rate #1					0.0 for
	#2					all years
23	Property Tax #1					0.0 for
	Rate #2					all years
24	Royalty Rate #1					0.0 for
	#2					all years
25	Federal Income #1					0.0 for
	Tax Rate #2					all years
26	State Income #1					0.0 for
	Tax Rate #2					all years
27	Investment #					0.0 for
	Tax Credit Rate#					
	#					all years
	#					
	#					
	#					
28	Depletion #1					.15 for
	Allowance Rate #2					all years

APPENDIX C

TECHNICAL NOTES FOR GCFM

TECHNICAL NOTES

NOTE 1: Memory Size Required

GCFM requires a real or virtual core memory size of 750,000 words.

NOTE 2: GCFM Subroutines

The names and general functions of the GCFM main program, subroutines, and segments are presented in Table C-1. This table is included for the reader who wishes to study the model in depth.

TABLE C-1
DESCRIPTION OF GCFM SUBROUTINES

<u>SEGMENT SUBROUTINE</u>	<u>OTHER SUBROUTINES CALLED</u>	<u>FUNCTION OF SUBROUTINE</u>
MAIN		
MAIN	UTILITY PRODCR FINANC	GCFM Driver
CHANGE		Change routine for all three modules
ICHG		Change integer values
RCHG		Change real values
CHGERR		Verifies input values
DDUMP		Data dump routine for all three modules
IPRT	IPRT RPRT	Data dump subroutine
RPRT		Data dump subroutine
ENTR		
FININ	SVECTD SVECT DVECT	Financial data input
SVECT		Calculates annual values based on entered
DVECT		first value, rate of change, first year,
		last year
PRODIN	SVECTD SVECT	Producer plant (field) inputs
SVECTD		Single vector inputs which takes defaults
UTILIN	SVECT	Power plant inputs
UTIL		
UTILITY	PLNTIO UTILIN UTICAL CHANGE UTIPRT FINANC STDES BTDES STCST BTCST	
HEAD		Writes header of output reports
PLNTIO	HEAD	Read and write plant data
UTICAL		Compute capital investments over plant life
UTIPRT	DDUMP	Print P. plant design and capital cost report
UDES		
STUES		Cycle calculations for single and double flashed
		and dry steam geo. plants
BTUES		Binary cycle calculations for supercritical
		isobutane
STCST	Use the following thermo- dynamic function subroutines	Steam plant capital cost calculations from
		Battelle "Geocost" model
BTCST		Binary plant capital cost calculations from
		Battelle "Geocost" model
WHL		Enthalpy of saturated water liquid H(P)
WHG		Enthalpy of saturated water vapor H(P)
WPT		P(T) for saturated water vapor
WSL		Water liquid entropy S(P)
WSG		Water vapor entropy S(P)
WSV		V(P) for saturated water vapor
WDH		H(P,T) for superheated water vapor
WDS		S(P,T) for superheated water vapor
BPT		P(T) for saturated isobutane vapor
BHC		N(P) for saturated isobutane vapor
BHL		H(P) for saturated isobutane liquid
BSG		S(P) for saturated isobutane vapor
BSL		S(P) for saturated isobutane liquid
BDH		H(P,T) for superheated isobutane vapor
BDS		S(P,T) for superheated isobutane vapor
BHS		N(P,S) for superheated isobutane vapor
BSV		V(P,T) for superheated isobutane vapor
BTP		T(P) for saturated isobutane vapor
BDT		T(P,S) for superheated isobutane vapor
PROD		
PRODCR	PRODIN PRODES CHANGE PROPRT FINANC	Driver for producer field calculations
PRODES		Calculate costs for producer field
PROPRT	DDUMP	Produce field design and capital cost report
FLOW		
FINANC	FININ CHANGE FINCHK CASH	Driver for financial calculations
FINCHK		Write error messages if years and lifetime
		inconsistent
CASH	CASFLO PWORTH LEVEL CONSTR FINPRT	Financial calculations
CONSTR		Calculate debt/equity, interest, fee during
		construction period
PWORTH		Calculate present worth of cash flows
LEVEL		Calculate net present value of revenue streams
CASFLO		Calculate annual cash flow
FINPRT	FINPR2, DDUMP	Print market price reports
FINPR2		Print breakeven price reports

NOTE 3: GCFM Debugging Outputs

GCFM contains options that produce output of a great many values of intermediate calculations. These options were built into the code for debugging during the development of the model, but they could be of interest to programming analysts who wish to understand the model better, or to verify its accuracy.

WARNING: Avoid using these options unless you are very familiar with Fortran and the GCFM model. The options produce copious amounts of partially documented output, in some cases will inhibit normal use of certain features of the model, and will at times deliver unlabelled outputs to the technical screen.

To perform a run with the debugging option turned on, the user must enter the number 10883 instead of 1,2, or 3 when GCFM asks which module is to be used.

GCFM will then print:

ENTER DEBUGGING CODE.

The user then enters one of the following codes to select an option:

<u>CODE</u>	<u>OPTION</u>
1	Turn on debug output for power plant module only.
2	Turn on debug output for field module only.
3	Turn on debug output for financial module only.

4

Turn on debug output for all three modules. Under this option, all change menus are prevented from being displayed or printed out.

The user should then enter 1, 2 or 3 to select a module in the normal manner. That module will then be operated with the selected debug option in effect.

The debugging option is turned off the next time a module is selected.

The reader should note that most of the additional outputs generated by these options will not be interpretable unless the FORTRAN source code is examined in detail.

Department Approval: Paula M. Medville

MITRE Project Approval: Paula M. Medville