A SIMULATION MODEL OF AN OIL COMPANY

by

KOK THIAM NG

A thesis
presented to The University of Manitoba
in partial fulfillment of the
requirements for the degree of
Master of Science (Operational Research)
in the
Faculty of Administrative Studies

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ABSTRACT

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This thesis describes the development and application of a continuous simulation feedback model using the DYNAMO computer language to investigate the dynamic relationships governing production, proven reserves, cash flow, return on investment and other financial factors in a hypothetical independent oil company.

Computer simulation runs are performed to trace the impact through the system over time of different exploration and production policies and to see how various external shocks can affect the performance of the company. It has been demonstrated that such methods provide policy makers with valuable insights as to how the system works and serves to stimulate the search for policies that will not only counter deteriorating system behaviour but will also be robust against uncontrollable shocks on the system. Finally various possible modifications to the model to make it more realistic are discussed.

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ACKNOWLEDGEMENTS

First and foremost, I would like to express my deepest gratitude to Professor Roger I. Hall, Chairman of my Thesis Supervisory Committee, for without his patient guidance, assistance and encouragement this thesis simply could not have been completed. I am indebted to Professors F.E.F. Dunford and S.A. Bukhari for undertaking the arduous task of reading and assessing this thesis.

I would also like to thank the teaching staff of the Department of Earth Science and the Natural Resources Institute of The University of Manitoba for providing me with valuable data for this study. I am also deeply indebted to Mr. Daniel Lai for the tedious task of helping me to run the computer programs and produce the plots using the Versitex plotter.

Last but not least, I wish to express my deep appreciation to Mrs. Pamela Poulson and Miss Susan Harder for turning my handwritten missives into neatly typed drafts.

CHAPTER 1

INTRODUCTION

This thesis is concerned with applying System Dynamics to the modelling of a hypothetical independent oil company. System Dynamics is a method of synthesis and analysis, based on system model building and continuous simulation techniques. It combines physical flows, such as inventories of products and cash, with information feedback representing decision processes in the system, to facilitate the understanding and hence design of managerial control policies (Coyle, 1977).

There are two main types of oil operators, namely the independents and majors. Although at times it may be difficult to distinguish clearly between these two, it is generally agreed that the main characteristic of independents is their 'small' size compared to the majors. Actually, some independent operators, involving annual expenditures of millions of dollars, would be considered giants in other industries. The size of independent companies may range from a one-man operation, to a firm with several geologists, landmen and engineers. Independents can range from operators who merely promote deals, operators who are hired by other companies to drill wells, operators who own drilling rigs and drill for themselves as well as for others, to some who are both producers, drillers and even operate small refineries. By contrast, the majors are the large multinational oil companies. Generally, though not necessarily, the majors are fully integrated (i.e., carry on exploration, production, transportation, refining and marketing operations). The giant companies like Exxon, Shell and Imperial fall under this category.

In this study, the term 'independent' denotes an organization with a few geologists, landmen and engineers, primarily nonintegrated, whose principal business is to find and produce oil. In actuality, be it major or independent, the main bulk of the annual expenditure is spent on exploration, development and production, and represents the main core of the operations.

With their limited capital, independents must be extremely careful in deciding which ventures to enter into and how much to invest in each one. The combination of complexity of the system and risk involved in drilling presents an interesting situation to study. The purpose in applying the System Dynamics approach to model an oil company has been basically two-fold:

1) to study the impacts of various policies available to a company, and,
2) to identify (hopefully) the factors that are critical in influencing the long run profitability and survival of the company.

The information for the construction of the model draws primarily from discussions with people in the oil industry, industry statistics and company operating reports.

Some very sweeping approximations have been made simply to get the model going and at this stage the model represents a working hypothesis of how an independent company works. Oil executives, for example, could hopefully take this embryonic model, adapt it to their own organisations and use it for their own purposes.

CHAPTER 2

THE METHODOLOGY

The model relates to a hypothetical, and conceptually plausible oil company. The construction of the model involves the following steps (Coyle, 1977; Axelrod, 1976; Hall, 1978, 1979):

a) From interviews with people in the oil industry and from industry statistics and company operating reports, an influence diagram, depicting the operations of a typical oil company, is drawn.

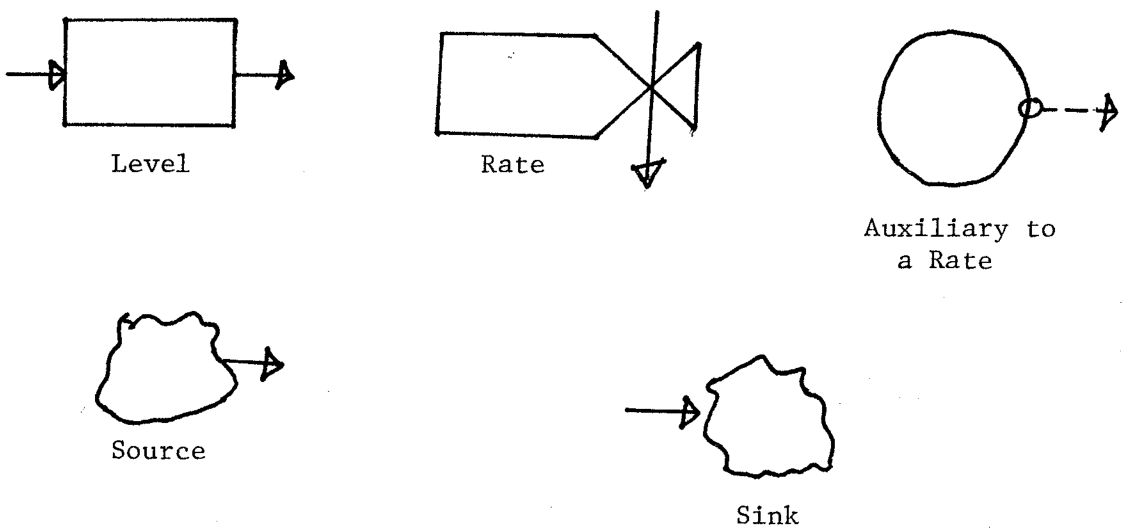
Quoting Hall (1978):

> The basic elements of an influence diagram are quite simple. The policy variables that can be manipulated, the goals or performance criteria that are to be aimed for and the intervening causes and effects can all be thought of as concept variables. These concepts are represented as points on a sheet of paper, and the causal assertions linking these concepts are represented as arrows between these two points. A positive sign denotes that an increase in the concept variable at the tail of the arrow will lead to an increase in the variable at the head, and that of a decrease leads to a decrease. A negative sign indicates the opposite movement of the head variable from that of the tail one (p. 104).

b) A system flow diagram is developed from the influence diagram to facilitate programming. This employs control engineering symbols to categorize the conserved subsystems (e.g., inventories and cash balances) and the rates that control the flows in the subsystems. The interconnecting web of information that determines, through policies and leverage points, the activities or rates in the conserved subsystems, is added. Fig. 2-1 shows the standard flow diagram symbols.

c) A computer system simulation model is programmed from the system flow diagrams using the system simulation language Dynamo (Pugh, 1970). This language uses parallel processing (i.e., the order of the computer cards or records is unimportant) and is especially designed to simulate

Figure 2.1: Standard System Flow Diagram Symbols



the dynamic feedback models of business, economic and social systems. This permits any of the model variables to be displayed in tabular and graphical form at any point during the simulation time.

d) Computer runs of the model, together with its flow diagrams and documented assumptions, are shown to the potential users who criticize the realism of the results. Changes are made to the model in light of these criticisms (a trivial task with the parallel processing facility of Dynamo, but often a major operation without this facility). The process is repeated until the opinion of the majority is expressed that the model represents reality for the purpose at hand.

e) Experiments are run by changing the values of the various model variables. The objective is to identify the impact of these changes on the company performance and to aid in the adoption of suitable policies.

Sources For Building The Model

The data for this model is gathered from interviews with the professors at the department of Earth Science and the Natural Resources Institute of the University of Manitoba; a few oil operators in Alberta; correspondence with the former deputy EDP manager of the National Petroleum Company of Malaysia; the training manager of Shell Oil Company, Malaysia; annual reports of oil companies; literature describing the operations of the oil industry (Ball et al., 1965; Business Week, 1980a, 1980b, 1980c; Stuart, 1981; Tufte, 1975), brochures and drilling statistics published by the Canadian government and the oil industry (Imperial, 1979).

CHAPTER 3

OVERVIEW OF THE MODEL

The simplified influence diagrams of an independent oil company are shown in Fig. 3.1-3.3. The model is divided into the following sectors: (1) Lease, (2) Exploration, (3) Completion Stage, (4) Producing Wells, (5) Proven Wells, (6) Production Capacity, (7) Production, (8) Financial Accounting, (9) Investment Flows and Financial Performance, and (10) Exploration Policy. The detailed system flow diagrams of the various sectors required for programming a simulation model are shown in Fig. A.1-A.27 in appendix A. A brief outline of each sector and what function it performs follows:

(1) Lease sector

This sector keeps track of the amount of raw land holdings. This amount is increased by the rate of acquisition of acreage, depleted by the rate of usage of acreage for exploratory drilling solely by the company or in partnership with another or farmed out to another operator and also depleted by the rate of expiry of raw land holdings leases. The price of the acreage is affected by the quality of geological information about it, which in turn affects the rate of acquisition of acreage with available funds.

(2) Exploration sector

The rate of exploratory drilling is governed by the amount of spending on exploration and the availability of leased acreage. The amount of capital budgeted for exploration, it is posited, depends on the company's estimated life span (i.e., the time by which the company's would go out of the business, given average production over the pre-

Figure 3.1 Oil exploration and well completion sector Influence Diagram

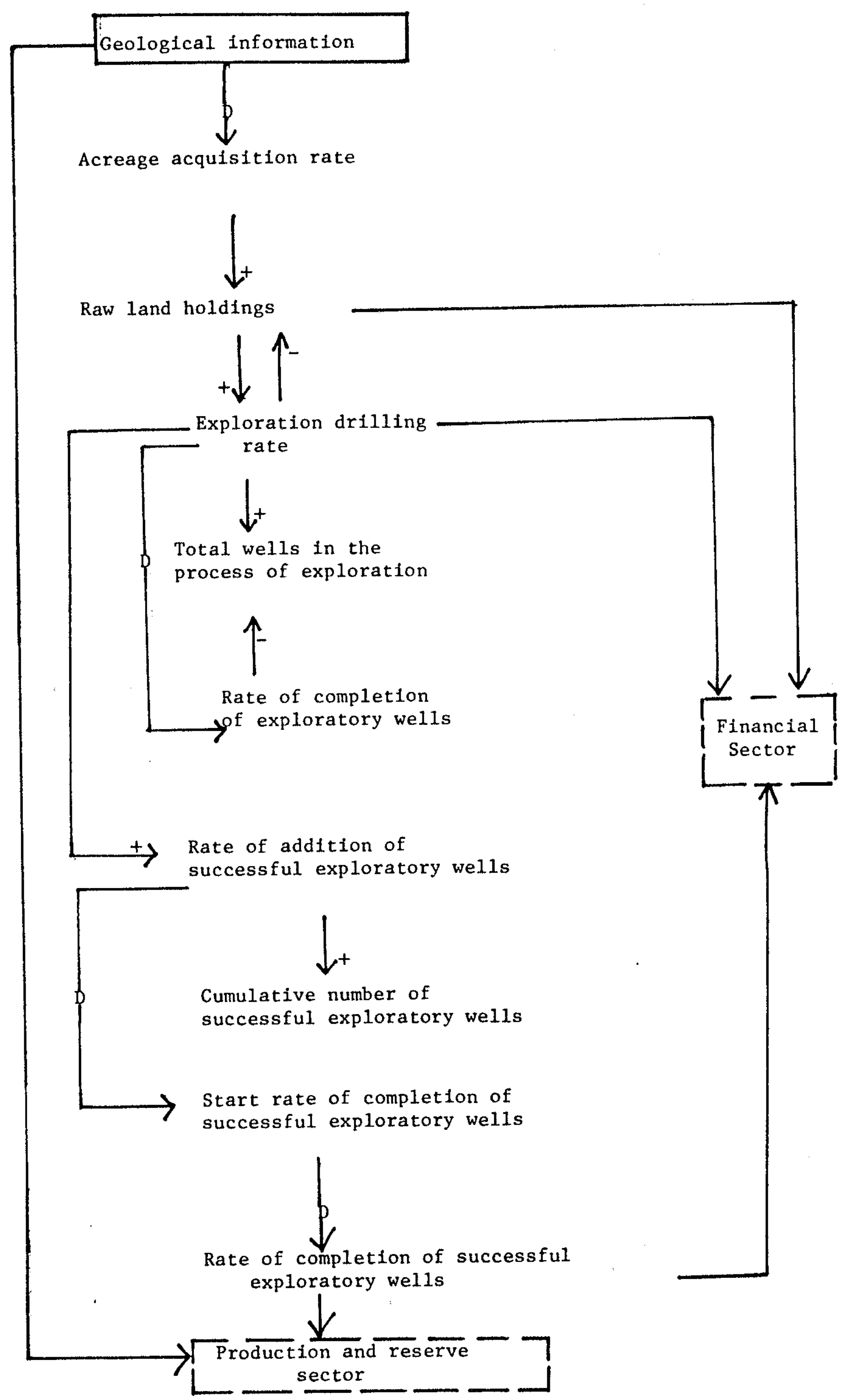


Figure 3.2 Production and Reserves Sector - Influence Diagram

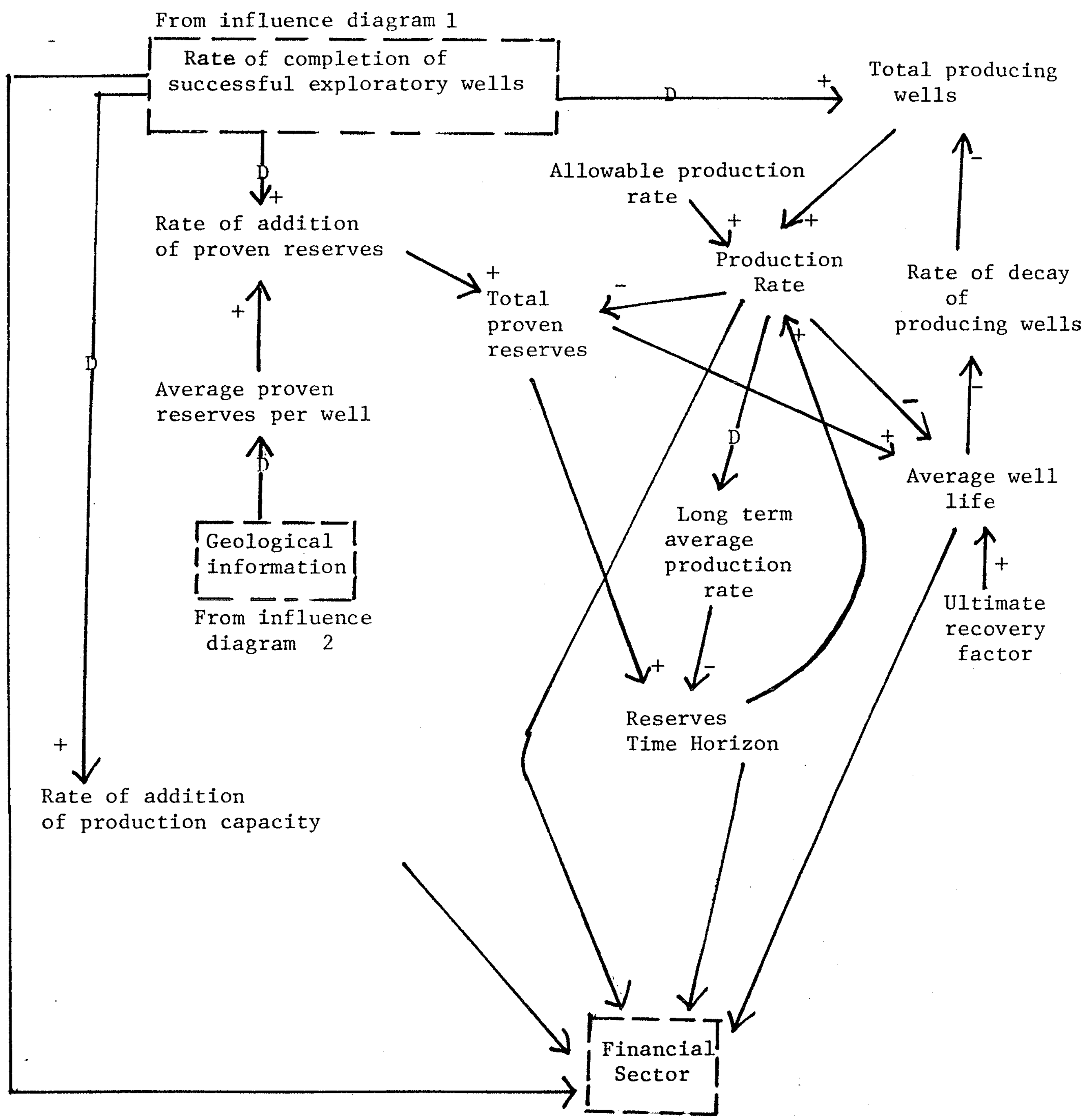
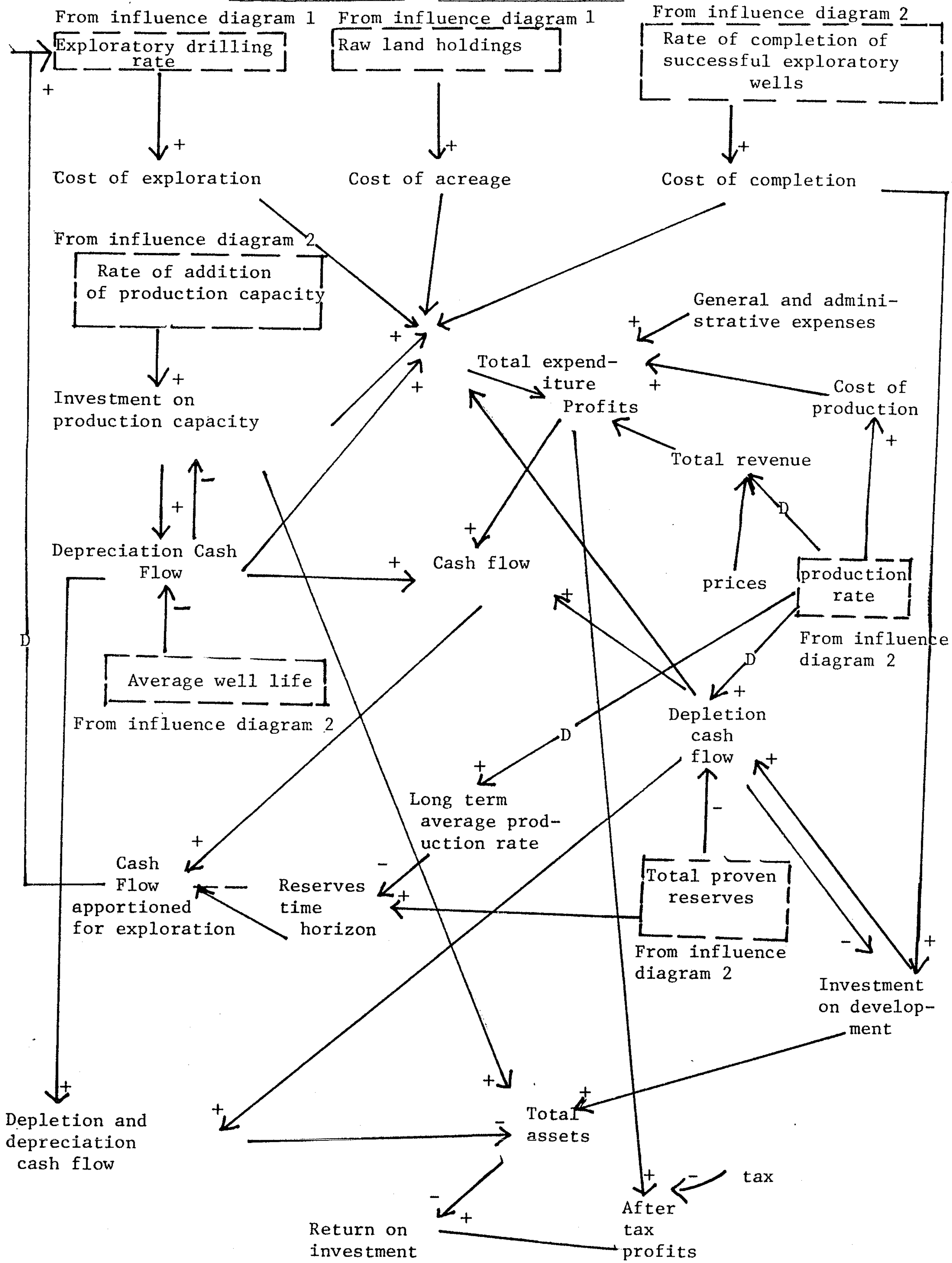


Figure 3.3 Financial Sector - Influence Diagram



vious two years, if no further reserves were to be located) and the company desired life horizon. The total number of successful exploratory wells are affected by exogenously generated success ratios.

(3) Completion stage sector

This sector keeps an account of wells in the process of completion.

(4) Producing wells sector

The total number of producing wells is increased by the rate of completion of wells and decreased by the rate of depletion of producing wells.

(5) Proven wells sector

This sector records the total proven reserves from wells drilled solely by the company or under a 50% partnership.

(6) Production capacity sector

The rate of production capacity addition is affected by the rate of completion of wells and the desired production rate per well. It is assumed that the desired production rate per well is scaled up or down according to the ratio of the company's actual lifetime (at current production rates) to its desired life horizon.

(7) Production sector

The production rate is constrained by the total production capacity, or by the total number of producing wells and the maximum allowable rate of production per well. This is then used to compute the short term average production rate (over a six month period) and long term average production rate (over twenty-four months).

(8) Financial accounting sector

This sector keeps a record of yearly sales revenue and total expenses, monthly costs of both exploration and well completion, and general and administrative expenses. The total annual expenditure includes:

(1) Cost of production

(2) Cost of exploration

(3) Cost of well completion

(4) Cost of production capacity addition

(5) Cost of leased acreage

(6) General and administrative expenses, and

(7) Depreciation and depletion expenses

The company receives full revenues from its own producing wells, a portion for those wells drilled in partnership and a royalty payment from those farmed out. The yearly before-tax profit is calculated as the difference of the end of the year total sales revenue and total expenditure. Cash flow is then calculated as the sum of after-tax profits, depletion and depreciation cash flows.

(9) Investment flows and financial performance sector

The depreciated values of the investment in development and production capacity are updated and recorded. These are then used to calculate the value of the total assets. Return on investment is then computed to be the ratio of after-tax profits to the value of the total assets expressed as a percentage.

(10) Exploration policy sector

The ratio of the company's actual lifetime stock of oil to its desired life horizon is used to drive its exploration policies. The company's actual lifetime is the time by which the company would go out of the business, given average production over the last two years, if no further reserves were to be located. A lower ratio reflects a threat to the company's future existence due to declining reserves. As such the company would be willing to release more funds for exploration in the hope of acquiring more reserves.

CHAPTER 4

DETAILED EXPLANATION OF THE MODEL

This chapter describes in detail the computer program of the model. The purpose is to make absolutely clear the assumptions and formulation of the model so that it can be argued, reviewed and improved. The listing of the equations in Dynamo simulation language syntax (see Pugh, 1970) together with the complete documentation are shown in Appendix B. To assist the reader, the equations are numbered to provide a cross-reference between the following descriptions and the model listing in Appendix B and the system flow diagrams in Appendix A. As a further service to finding one's way through the model, an alphabetic listing of all variables in the model and where they are used is to be found in Appendix C.

It should be stressed that the parameter values used in the model are only estimates which appear plausible to the author. They were the best estimates available from the literature or from people in the oil industry contacted at the time.

The Equations of the Model

LEASE SECTOR

Quality of geogological information: The equations, written in the DYNAMO programming language, representing this information follow:

```
 QUALITY OF GEOLOGICAL INFORMATION

ACPA.K=TABHL(TAB1,QCGI.K,1,4,1)                            2, A
TAB1=5/7/10/14                                             2.1, T
QCGI.K=SAMPLE(NORMRN(MQC,SQC),3,MQC)                       3, A
MQC=2.5                                                    3.1, C
SQC=0.6                                                    3.2, C
    ACPA    - ($/ACRE/M) AVE COST OF ACREAGE
    TAB1    - ($/ACRE/M) TABLE GIVING COST OF ACREAGE
    QCGI    - (1) QUALITY COEFFICIENT OF GEOLOGICAL
                INFORMATION
    MQC     - (1) MEAN QUALITY COEFFICIENT OF GEOLOGICAL
                INFORMATION
    SQC     - (1) STANDARD DEVIATION OF QUALITY
                COEFFICIENT OF GEOLOGICAL INFORMATION
```

A firm may either acquire leased acreage for exploration speculatively prior to the actual drilling decision, or acquire it after the firm has become interested in a particular venture. If the firm enters a relatively unexplored area (with low state of information) and buys leases speculatively, the price per acre will be low. Then the firm may purchase information by seismographic test, core drilling or drilling to evaluate the acreage.

But if the acquisition of leases is begun after there is evidence of interest in the area (perhaps through already available seismographic information, shootings or an active lease play) or after information is available about the geological quality of the leased acreage (such as a discovery) the price will be higher. The values of the quality coefficient of geological information signify the amount of information available for the acreage. It is modelled to follow a normal distribution where the values can roughly be interpreted as below:

QCGI = 1 'fair' amount of information representing some minimal knowledge about the likely presence of oil

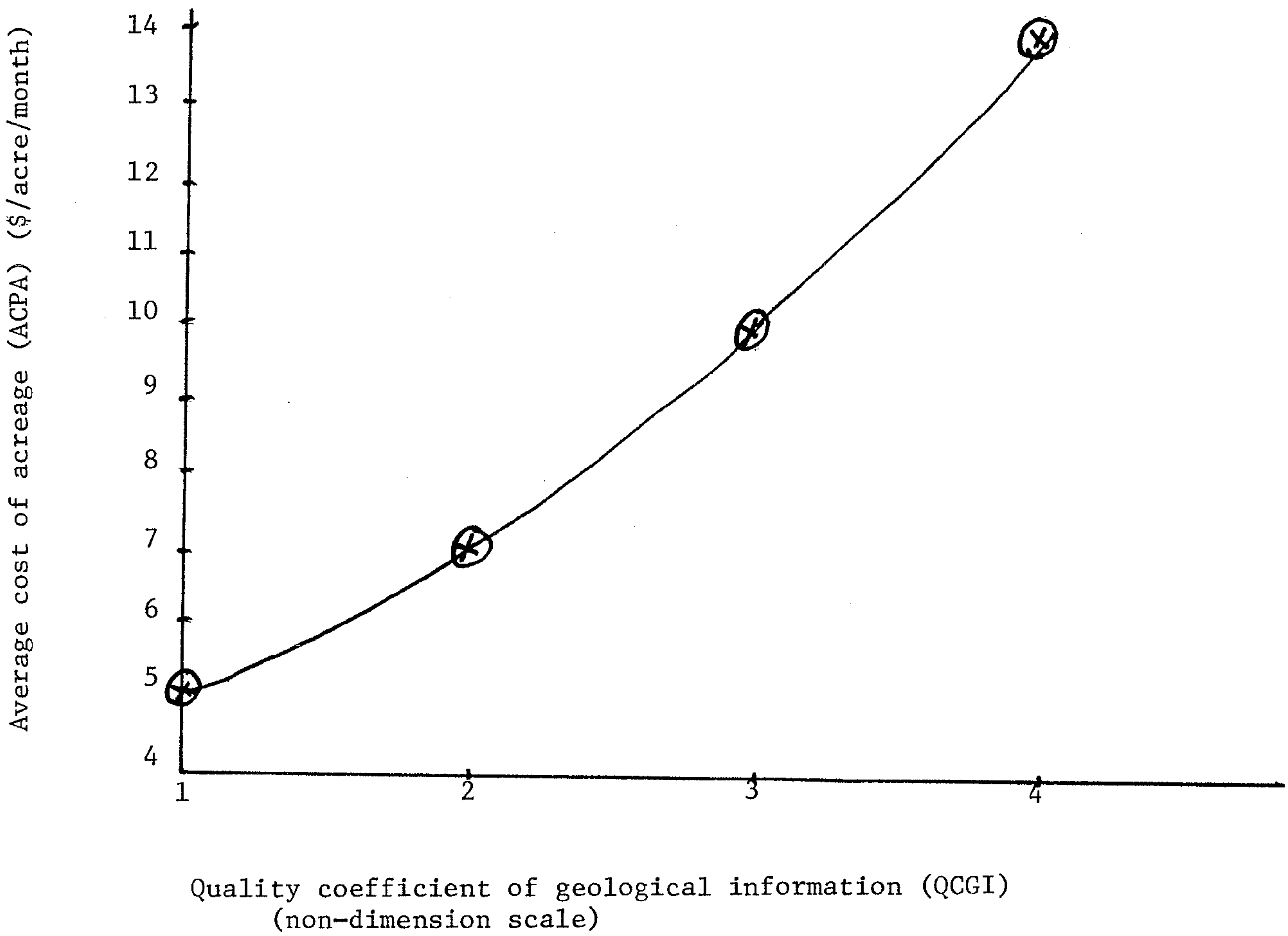
QCGI = 2 'good' amount of information representing a good indication that oil is present

QCGI = 3 'very good' amount of information representing a very good indication that oil is present

QCGI = 4 'Excellent' amount of information representing perfect knowledge that oil is present

Fig 4.1 shows the relationship between the average price of leasing acreage and the quality coefficient of geological information. It is seen that the price of acreage increases as the quality coefficient of geological information increases.

Figure 4.1 Relationship between the average cost of acreage and the quality coefficient of geological information



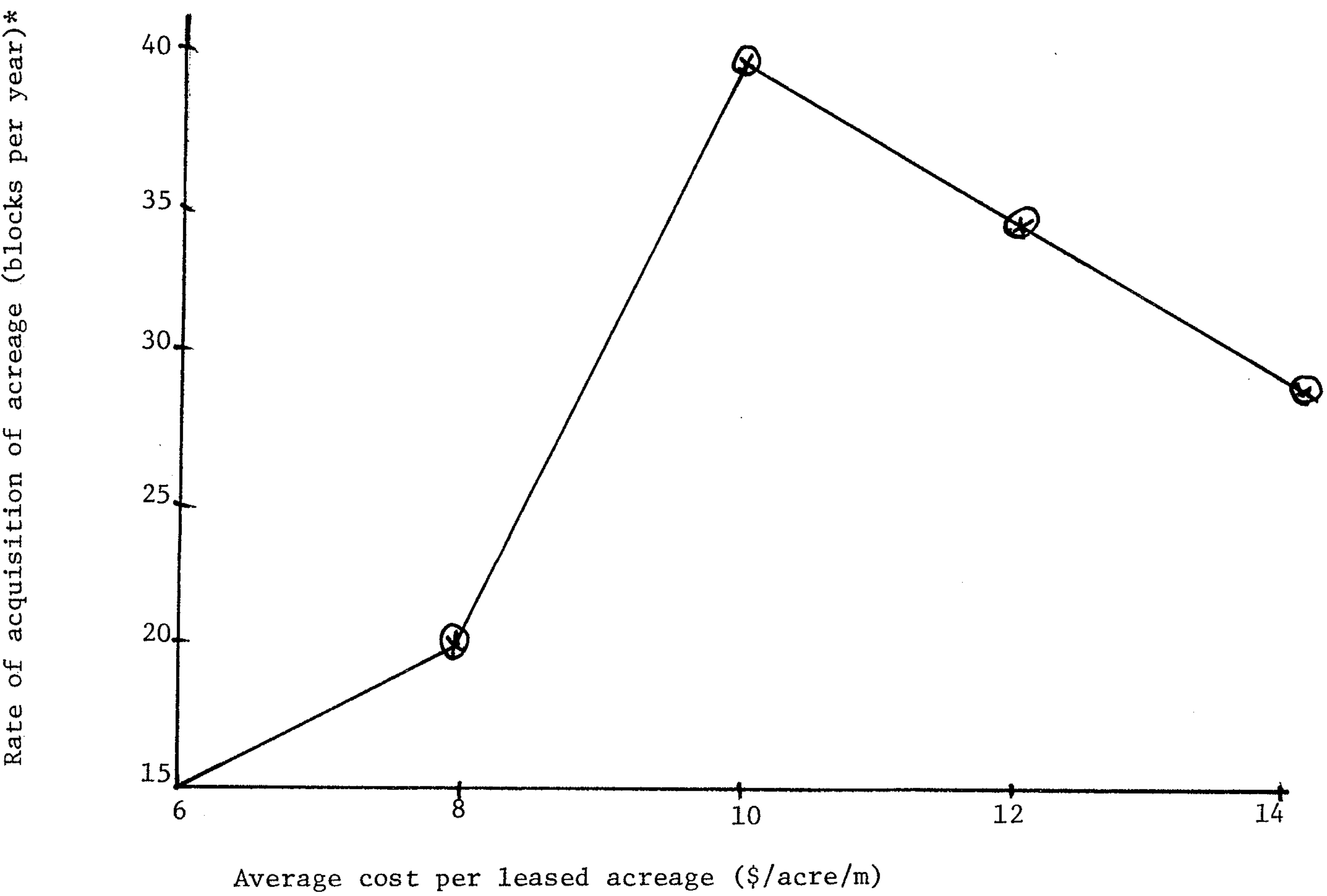
<u>Raw land holdings</u>: The equations representing raw land holdings are as follows:

```
 DIVISION OF RAW LAND HOLDINGS

RLA.K=TABHL(TAB2,ACPA.K,6,14,2)*APB/12             4, A
APB=80                                             4.1, C
TAB2=15/20/40/35/30                                4.2, T
RALA.KL=RLA.K+MAX(DRHOL.K-RLHOL.K,0)/MEXP          5, R
RALA=RLA                                           5.1, N
RLHOL.K=RLHOL.J+DT*(RALA.JK-RULDS.JK-RULDP.JK-     6, L
  RULFO.JK-RLEXP.JK)
RLHOL=BRLHOL                                       6.1, N
BRLHOL=3000                                        6.2, C
RULDS.KL=AREXPS.JK*SPW                             7, R
RULDP.KL=AREXPP.JK*SPW                             8, R
SPW=40                                             8.1, C
MEXP=60                                            8.2, C
RULFON.K=ARALA.K*PFO                               9, A
PFO=0.05                                           9.1, C
RULFO.KL=RULFON.K+MIN(MFO*RLHOL.K,MAX(RLHOL.K-     10, R
  DRHOL.K,0))/MEXP
RULFO=RULFON                                       10.1, N
MFO=.1                                             10.2, C
ANRULD.K=SMOOTH(RULDS.JK+RULDP.JK+RULFON.K,TTARA)  11, A
TTARA=12                                           11.1, C
DRHOL.K=ANRULD.K*MEXP                              12, A
ARALA.K=SMOOTH(RALA.JK,MEXP)                       13, A
ARULD.K=SMOOTH(RULDS.JK+RULDP.JK+RULFO.JK,MEXP)    14, A
RLEXP.KL=ARALA.K-ARULD.K                           15, R
    RLA     - (ACRES/M) RATE OF ACQUISITION OF ACREAGE
    TAB2    - (BLOCKS/Y) TABLE GIVING BLOCKS OF ACREAGE
                ACQUIRED PER YEAR
    ACPA    - ($/ACRE/M) AVE COST OF ACREAGE
    APB     - (ACRES/BLOCK) ACRES PER BLOCK OF ACREAGE
                ACQUIRED
    RALA    - (ACRES/M) RATE OF ACQUISITION OF ACREAGE
                PER MONTH
    DRHOL   - (ACRES) DESIRED AMOUNT OF RAW LAND HOLDINGS
    RLHOL   - (ACRES) AMOUNT OF RAW LAND HOLDINGS
    MEXP    - (M) EXPIRY TIME OF RAW LAND HOLDINGS
    RULDS   - (ACRES/M) RATE OF USAGE OF RAW LAND
                HOLDINGS FOR EXPLORATORY DRILLING
                (DRILLED SOLELY)
    RULDP   - (ACRES/M) RATE OF USAGE OF RAW LAND
                HOLDINGS FOR EXPLORATORY DRILLING(DRILLED
                UNDER PARTNERSHIP)
    RULFO   - (ACRES/M) RATE OF ACREAGE FARMED OUT
    RLEXP   - (ACRES/M) RATE OF EXPIRY OF RAW LAND
                HOLDINGS
    BRLHOL  - (ACRES) BASE VALUE OF RAW LAND HOLDINGS
    AREXPS  - (W/M) ACTUAL RATE OF EXPLORATORY
                DRILLING(SOLELY)
    SPW     - (ACRES/W) SPACING PER WELL
    AREXPP  - (W/M) ACTUAL RATE OF EXPLORATORY
                DRILLING(PARTNERSHIP)
    RULFON  - (ACRES/M) RATE OF ACREAGE NORMALLY FARMED
                OUT
    ARALA   - (ACRES/M) AV.RATE OF ACQUISITION OF ACREAGE
                OVER AV.TIME OF LEASES
    PFO     - (1) PROPORTION OF RAW LAND HOLDINGS FARMED
                OUT
    MFO     - (1) MAX FRACTION OF ACREAGE FARMED OUT
    ANRULD  - (ACRES/M) AVERAGE NORMAL RATE OF USAGE OF
                RAW LAND HOLDINGS
    TTARA   - (M) TIME TO AVERAGE RATE OF ACQUISITION OF

                RAW LAND
    ARULD   - (ACRES/M) AV. RATE OF USAGE OF ACREAGEOVER
                AV. TIME OF LEASES
```

Figure 4.2 Relationship between the average cost of acreage and the rate of acquisition of acreage



* The rate of acquisition of acreage is given as blocks per year (one block = 80 acres) whereas in the program it is given as acres per month).

Fig. 4.2 shows the relationship between the rate of acquisition of acreage (RLA,4) and the cost of leasing the acreage. It is assumed that the rate of acquisition increases as the cost per acre (i.e., quality of geological information) increases to a maximum of 3,200 acres per year and the rate begins to decrease thereafter even though the cost continues to increase. The rationale is that independent oil operators, with their insufficient financial resources to take risks and to pay rentals on large amounts of acreage, tend to hold relatively small amounts of acreage, particularly speculative acreage (i.e., acreage with low quality coefficient of geological information). Furthermore they cannot afford to purchase excessive amount of the expensive acreage. Leases are usually short-lived; no more than 10 years and usually 3 to 5 years. If no production is obtained from a lease before it expires, someone else may acquire it. The acquisition rate of acreage is increased if the actual acreage falls behind the desired acreage (RALA, 5). The desired acreage is calculated as five year's worth of leases at the average rate of exploration (DRHOL, 12).

After a discovery in a new area, spacing orders are issued by provincial regulatory commissions. These are determined from a hearing in which the operator requests what seems to him to be a desirable pattern in view of the economics of extraction and conservation of the discovered oil. Though the spacing pattern is not actually determined until after the well has been discovered, operators can anticipate when making the initial drilling decisions, what the spacing may be. If there is a 320-acre lease, and spacing is usually 40 acres, so there will be 16 potential locations. Thus, the spacing pattern obviously will affect the amount of investment required to develop the property and is an economic factor in the original drilling decision.

Spacing also becomes a decision problem after a discovery. The operator has to determine whether he will develop the property, with commission approval, on a particular pattern, say 40-acre spacing or 20-acre spacing. Although the total amount of petroleum to be recovered may be about the same under either spacing, the rate of recovery of funds will differ. For simplicity this model assumes the spacing per well as a constant of 40 acres. It is then clear that the rate of usage of raw land holdings for exploratory drilling (partnership or drilled solely; RULDS and RULDP, 7 and 8) is the product of actual rate of exploratory drilling and spacing per well.

Quite often the leaseholder may not desire to drill the lease himself and farm out or assign the lease to other operators in return for other considerations. Usually the other operator must first, drill wells to certain depths in the farmed out acreage within a specified time, second, furnish logs, cores, samples, and other geological information, and third, agrees to pay the leaseholder certain percentage of the sales revenue from farmed out wells that produce oil. Some of the reasons to farm out the acreage are: (i) funds are not available, (ii) there is a high risk of drilling, (iii) the acreage is insufficient to make it worth drilling alone, and (iv) the company wants the lease tested, for the reasons that if the well ever becomes productive, profits may be obtained from a retained interest in the farmed out, or nearby properties may be proved up (e.g., if the well is dry, valuable geological information may be obtained).

Independent operators usually hold a relatively small amount of speculative acreage and thus in many cases only a small amount of acreage will be farmed out. The model assumes that normally 5% of the acquisition land is farmed out (RULFON, 9) but up to 10% of raw land holdings over a 5 year period (MEXP 10) may be farmed out if the actual holdings exceed the desired (RULFO, 10). Also, the expiry rate of land holdings (RLEXP, 15) is the difference between the averages of the acquisition (ARALA, 13) and normal usage (ARULD, 14) rates (averaged over the life of leases; 5 years).

Sometimes the risk of drilling alone is so high or expensive that the operator must find partners to share the cost of drilling. However he will have to share the income if the well turns out to be productive. There are different types of partnership agreements. This model assumes a '50-50' partnership where the cost of drilling and income are equally shared. Under normal circumstances 40 percent of the land holdings will be explored in partnership (see next section).

The amount of raw land holdings (RLHOL, 6) is increased by the rate of acquistion of acreage (RALA, 5); and depleted by the rate of usage of acreage for exploratory drilling (RULDS, 7; RULDP, 8), rate of acreage farmed-out (RULFO, 10) and the expiry rate of raw land holdings (RLEXP, 15).

EXPLORATION SECTOR

Exploration rates of raw land holdings: The equations representing these exploration rates follow:

```
 EXPLORATION SECTOR
 EXPLORATION RATES OF RAW LAND HOLDINGS

EXPF.K=RULFO.JK/SPW                                    16, A
AREXPS.KL=MIN(CAPTS.K/ECPEWS.K,RLHOL.K*PDS/SPW)        17, R
AREXPP.KL=MIN(CAPTP.K/ECPEWP.K,RLHOL.K*PDP/SPW)        18, R
PDS=0.5/12                                             18.1, N
PDP=0.4/12                                             18.2, N
    EXPF   - (W/M) RATE OF EXPLORATORY DRILLING OF
               FARMED OUT WELLS
    RULFO  - (ACRES/M) RATE OF ACREAGE FARMED OUT
    SPW    - (ACRES/W) SPACING PER WELL
    AREXPS - (W/M) ACTUAL RATE OF EXPLORATORY
               DRILLING(SOLELY)
    CAPTS  - ($/M) CAPITAL AVAILABLE FOR EXPLORATORY
               DRILLING(SOLELY)
    ECPEWS - ($/W) ESTIMATED COST OF EXPLORATION PER
               WELL TO BE DRILLED SOLELY
    RLHOL  - (ACRES) AMOUNT OF RAW LAND HOLDINGS
    PDS    - (1/M) PROPORTION OF RAW LAND HOLDINGS TO BE
               USED FOR SOLE DRILLING
    AREXPP - (W/M) ACTUAL RATE OF EXPLORATORY
               DRILLING(PARTNERSHIP)
    CAPTP  - ($/M) CAPITAL AVAILABLE FOR EXPLORATORY
               DRILLING(PARTNERSHIP)
    ECPEWP - ($/W) ESTIMATED COST OF EXPLORATION PER
               WELL TO BE DRILLED UNDER PARTNERSHIP
    PDP    - (1/M) PROPORTION OF RAW LAND HOLDINGS TO BE
               USED FOR DRILLING UNDER PARTNERSHIP
```

The rate of exploratory drilling of farmed out wells (EXPF, 16) is made equal to the rate of acreage farmed out (RULFO, 10) divided by the spacing per well (SPW). The actual rate of exploratory drilling (drilled solely by the oil company) (AREXPS, 17) is governed by the capital available for exploratory drilling, (CAPTS, 163), estimated cost per exploratory well (ECPEWS, 108) and the availability of raw land holdings (RLHOL, 6). The actual rate of exploratory drilling under partnership (AREXPP, 18) follows the same logic. In this model it is assumed that 50 percent of the raw land holdings are to be used for sole exploratory drilling and 40 percent for exploratory drilling under partnership respectively.

<u>Well drilled solely by the company</u>: The equations representing this part are as follows:

```
RATE OF DRILLING WILDCAT & DEVELOPMENT SOLELY BY
 COMPANY

WAREXS.K=WS*AREXPS.JK                                    19, A
DAREXS.K=(1-WS)*AREXPS.JK                                20, A
WS=0.7                                                   20.1, C
TWES.K=TWES.J+DT*(AREXPS.JK-RCWES.JK)                    21, L
TWES=3                                                   21.1, N
RCWES.KL=DELAY3(AREXPS.JK,DCE)                           22, R
DCE=18                                                   22.1, C
    WAREXS - (W/M) RATE OF EXPLORATORY DRILLING (WILD
               CAT WELLS DRILLED SOLELY)
    WS     - (1) PROPORTION OF RATE OF EXPLORATORY
               DRILLING(DRILLED SOLELY)WHICH IS WILD CAT
               WELLS
    AREXPS - (W/M) ACTUAL RATE OF EXPLORATORY
               DRILLING(SOLELY)
    DAREXS - (W/M) RATE OF EXPLORATORY
               DRILLING(DEVELOPMENT WELLS DRILLED
               SOLELY)
    TWES   - (W) TOTAL WELLS IN EXPLORATION
               PROCESS(DRILLED SOLELY)
    RCWES  - (W/M) RATE OF COMPLETION OF EXPLORATORY
               DRILLING(WELLS DRILLED SOLELY
    DCE    - (M) DELAY IN COMPLETING THE EXPLORATION
```

In this study two types of exploratory wells are distinguished: (a) wild-cat wells, and (b) development wells. Wild-cat wells are those wells drilled on a geological structure or in an area never before productive. The success rate for these type of exploratory wells is usually low; the national average success rate being about 15 percent. In contrast, development wells are those drilled near other producing wells. Hence the success rate for development wells is relatively high; the national average success rate being about 70 percent. An exploratory well is said to be successful if it contains a sufficient quantity of oil to warrant completing the well for production. For the purpose of this study, it is assumed initially that 70 percent of the rate of exploratory drilling done is 'wild-cat' (WAREXS, 19) and 30 percent is 'development' (DAREXS, 20).

The total number of wells in process of exploration (drilled solely; TWES, 21) are increased by actual exploratory drilling rate (AREXPS, 17) and depleted by the completion rate of exploratory drilling (RCWES, 22). After an average delay of 18 months, the exploratory wells are completed (22).

Well drilled under partnership: The equations representing this part are:

```
UNDER PARTNERSHIP

WAREXP.K=WP*AREXPP.JK                                         23, A
DAREXP.K=(1-WP)*AREXPP.JK                                     24, A
WP=0.7                                                        24.1, C
    WAREXP - (W/M) RATE OF EXPLORATORY DRILLING (WILD
               CAT WELLS DRILLED UNDER PARTNERSHIP)
    WP     - (1) PROPORTION OF RATE OF EXPLORATORY
               DRILLING WITH PARTNER WHICH ARE WILD CAT
               WELLS
    AREXPP - (W/M) ACTUAL RATE OF EXPLORATORY
               DRILLING(PARTNERSHIP)
    DAREXP - (W/M) RATE OF EXPLORATORY DRILLING(
               DEVELOPMENT WELLS DRILLRD UNDER
               PARTNERSHIP)
```

The logic of equations 23 and 24 is exactly the same as equations 19 and 20 except that the exploratory drillings are done under partnership arrangements.

Success in drilling exploratory wells (wild-cat wells drilled solely by the company): The equations representing this part are:

```
SUCCESS IN DRILLING EXPLORATORY WILDCAT WELLS:
SOLELY BY COMPANY

WRSEWS.KL=SAMPLE(NORMRN(WMSES.K,WSSES.K),1,WMSES.K) 25, R
WMSES.K=WSRS*WAREXS.K                               26, A
WSRS=0.15                                           26.1, C
WSSES.K=0.01*WAREXS.K                               27, A
WTSEWS.K=WTSEWS.J+DT*WRSEWS.JK                      28, L
WTSEWS=BSEWS                                        28.1, N
BSEWS=2                                             28.2, C
    WRSEWS - (W/M) RATE OF ADDITION OF SUCCESSFUL
               EXPLORATORY WILD CAT WELLS DRILLED SOLELY
    WMSES  - (W/M) MEAN VALUE OF RATE OF ADDITION OF
               SUCCESSFUL EXPLORATORY WILD CAT WELLS
               DRILLED SOLEY
    WSSES  - (W/M) STANDARD DEVIATION OF RATE OF
               ADDITION OF SUCCESSFUL EXPLORATORY WILD
               CAT WELLS DRILLED SOLEY
    WSRS   - (1) SUCCESS RATIO OF EXPLORATORY WILD CAT
               WELLS DRILLED SOLELY
    WAREXS - (W/M) RATE OF EXPLORATORY DRILLING (WILD
               CAT WELLS DRILLED SOLELY)
    WTSEWS - (W) CUMULATIVE NUMBER OF SUCCESSFUL
               EXPLORATORY WILD CAT WELLS DRILLED SOLELY
    BSEWS  - (W) BASE VALUE OF SUCCESSFUL EXPLORATORY
               WILD CAT WELLS DRILLED SOLELY
```

It is assumed that the rate of addition of successful exploratory wild-cat wells drilled solely by the company (WRSEWS, 25, 26 and 27) follows a normal distribution with mean as 15% of the rate of exploratory drilling (wild-cat wells drilled solely) and standard deviation of 1 percent of the rate of exploratory drilling (wild-cat wells drilled solely).

The cumulative number of successful exploratory wild-cat wells drilled solely (WTSEWS, 28) is increased by the rate of addition of successful exploratory wild-cat wells drilled solely (WRSEWS, 25).

<u>Success in drilling exploratory wells (wild-cat wells drilled under partnership:</u> The equations representing this part are:

```
 UNDER PARTNERSHIP

WRSEWP.KL=SAMPLE(NORMRN(MSEP.K,SSEP.K),1,MSEP.K)      29, R
MSEP.K=WSRP*WAREXP.K                                  30, A
WSRP=0.15                                             30.1, C
SSEP.K=0.01*WAREXP.K                                  31, A
WTSEWP.K=WTSEWP.J+DT*WRSEWP.JK                        32, L
WTSEWP=BSEWP                                          32.1, N
BSEWP=2                                               32.2, C
    WRSEWP - (W/M) RATE OF ADDITION OF SUCCESSFUL
               EXPLORATORY WILD CAT WELLS DRILLED UNDER
               PARTNERSHIP
    MSEP   - (W/M) MEAN VALUE OF RATE OF ADDITION OF
               SUCCESSFUL EXPLORATORY WILD CAT WELLS
               DRILLED UNDER PARTNERSHIP
    SSEP   - (W/M) STANDARD DEVIATION OF RATE OF
               ADDITION OF SUCCESSFUL EXPLORATORY WILD
               CAT WELLS DRILLED UNDER PARTNERSHIP
    WSRP   - (1) SUCCESS RATIO OF EXPLORATORY WILD CAT
               WELLS DRILLED UNDER PARTNERSHIP
    WAREXP - (W/M) RATE OF EXPLORATORY DRILLING (WILD
               CAT WELLS DRILLED UNDER PARTNERSHIP)
    WTSEWP - (W) CUMULATIVE NUMBER OF SUCCESSFUL
               EXPLORATORY WILD CAT WELLS DRILLED UNDER
               PARTNERSHIP
    BSEWP  - (W) BASE VALUE OF TOTAL NUMBER OF
               SUCCESSFUL EXPLORATORY WILD CAT WELLS
               DRILLED UNDER PARTNERSHIP
```

The logic for equations 29 to 32 is exactly the same as equations 25 to 28 except that the exploratory drilling are done under partnership.

Success in drilling development wells (solely): Success in drilling development wells (solely by the company) is represented by:

```
SUCCESS IN DRILLING DEVELOPMENT WELLS
SOLELY BY COMPANY

DRSEWS.KL=SAMPLE(NORMRN(DMSES.K,DSSES.K),1,DMSES.K) 33, R
DMSES.K=DSRS*DAREXS.K                               34, A
DSRS=0.8                                            34.1, C
DSSES.K=0.05*DAREXS.K                               35, A
DTSEWS.K=DTSEWS.J+DT*DRSEWS.JK                      36, L
DTSEWS=0                                            36.1, N
TRSEWS.KL=WRSEWS.JK+DRSEWS.JK                       37, R
TWSES.K=TWSES.J+DT*(TRSEWS.JK)                      38, L
TWSES=4                                             38.1, N
    DRSEWS - (W/M) RATE OF ADDITION OF SUCCESSFUL
               EXPLORATORY "DEVELOPMENT" WELLS DRILLED
               SOLELY
    DMSES  - (W/M) MEAN VALUE OF RATE OF ADDITION OF
               SUCCESSFUL EXPLORATORY DEVELOPMENT WELLS
               DRILLED SOLELY
    DSSES  - (W/M) STANDARD DEVIATION OF RATE OF
               ADDITION OF SUCCESSFUL EXPLORATORY "
               DEVELOPMENT" WELLS DRILLED SOLELY DT (M)
               SOLUTION INTERVAL
    DSRS   - (1) SUCCESS RATIO OF EXPLORATORY "
               DEVELOPMENT" WELLS DRILLED SOLELY
    DAREXS - (W/M) RATE OF EXPLORATORY
               DRILLING(DEVELOPMENT WELLS DRILLED
               SOLELY)
    DTSEWS - (W) CUMULATIVE NUMBER OF SUCCESSFUL
               EXPLORATORY "DEVELOPMENT" WELLS DRILLED
               SOLELY
    TRSEWS - (W/M) RATE OF ADDITION OF SUCCESSFUL
               EXPLORATORY WELLS DRILLED SOLELY
    WRSEWS - (W/M) RATE OF ADDITION OF SUCCESSFUL
               EXPLORATORY WILD CAT WELLS DRILLED SOLELY
    TWSES  - (W) CUMULATIVE NUMBER OF SUCCESSFUL
               EXPLORATORY WELLS DRILLED SOLELY
```

It is assumed that the rate of addition of successful exploratory "development" wells drilled solely by the company (DRSEWS, 33) follows a normal distribution with mean success ratio of 80 percent and standard deviation as 5 percent of the rate of exploratory drilling (development wells drilled solely). The cumulative number of successful exploratory "development" wells drilled solely is increased by the rate of addition of successful exploratory "development" wells drilled solely (DRSEWS, 33). The cumulative number of successful exploratory wells drilled solely (including development and wild-cat wells) (TWSES, 38) is increased by the rate of addition of successful exploratory wells drilled solely (TRSEWS, 37).

<u>Success in drilling development wells (under partnership):</u> The equations to represent this part are:

```
UNDER PARTNEWSHIP

DRSEWP.KL=SAMPLE(NORMRN(DMSEP.K,DSSEP.K),1,DMSEP.K) 39, R
TWEP.K=TWEP.J+DT*(AREXPP.JK-RCWEP.JK)               40, L
TWEP=3                                              40.1, N
RCWEP.KL=DELAY3(AREXPP.JK,DCE)                      41, R
TRSEWP.KL=WRSEWP.JK+DRSEWP.JK                       42, R
TWSEP.K=TWSEP.J+DT*(TRSEWP.JK)                      43, L
TWSEP=4                                             43.1, N
DMSEP.K=DSRP*DAREXP.K                               44, A
DSRP=0.7                                            44.1, C
DSSEP.K=0.05*DAREXP.K                               45, A
DTSEWP.K=DTSEWP.J+DT*DRSEWP.JK                      46, L
DTSEWP=0                                            46.1, N
    DRSEWP - (W/M) RATE OF ADDITION OF SUCCESSFUL
               EXPLORATORY "DEVELOPMENT" WELLS DRILLED
               UNDER PARTNERSHIP
    DMSEP  - (W/M) MEAN VALUE OF RATE OF ADDITION OF
               SUCCESSFUL EXPLORATORY DEVELOPMENT WELLS
               DRILLED UNDER PARTNERSHIP
    DSSEP  - (W/M) STANDARD DEVIATION OF RATE OF
               ADDITION OF SUCCESSFUL EXPLORATORY "
               DEVELOPMENT" WELLS DRILLED UNDER
               PARTNERSHIP
    TWEP   - (W) TOTAL WELLS IN EXPLORATION
               PROCESS(DRILLED UNDER PARTNERSHIP)
    AREXPP - (W/M) ACTUAL RATE OF EXPLORATORY
               DRILLING(PARTNERSHIP)
    RCWEP  - (W/M) RATE OF COMPLETION OF EXPLORATORY
               DRILLING(WELLS DRILLED UNDER PARTNERSHIP
    DCE    - (M) DELAY IN COMPLETING THE EXPLORATION
    TRSEWP - (W/M) RATE OF ADDITION OF SUCCESSFUL
               EXPLORATORY WELLS DRILLED UNDER
               PARTNERSHIP
    WRSEWP - (W/M) RATE OF ADDITION OF SUCCESSFUL
               EXPLORATORY WILD CAT WELLS DRILLED UNDER
               PARTNERSHIP
    TWSEP  - (W) CUMULATIVE NUMBER OF SUCCESSFUL
               EXPLORATORY WELLS DRILLED UNDER
               PARTNERSHIP
    DSRP   - (1) SUCCESS RATIO OF EXPLORATORY "
               DEVELOPMENT" WELLS DRILLED UNDER
               PARTNERSHIP
    DAREXP - (W/M) RATE OF EXPLORATORY DRILLING(
               DEVELOPMENT WELLS DRILLRD UNDER
               PARTNERSHIP)
    DTSEWP - (W) CUMULATIVE NUMBER OF SUCCESSFUL
               EXPLORATORY "DEVELOPMENT" WELLS DRILLED
               UNDER PARTNERSHIP
```

The rate of addition of successful exploratory development wells drilled under partnership (DRSEWP, 39) is assumed to follow a normal distribution with mean success rate of 70 percent and standard deviation of 5 percent of the rate of exploratory drilling (development wells drilled under partnership). The cumulative number of successful exploratory development wells drilled under partnership (DTSEWP, 46) is increased by the rate of addition of successful exploratory "development" wells drilled under partnership (DRSEWP, 39). The cumulative number of successful exploratory wells drilled under partnership (TWSEP, 43) is increased by the rate of addition of successful exploratory wells drilled under partnership (TRSEWP, 42).

Success in drilling exploratory (farmed out) wells: The equations representing this part are:

```
 FARMED OUT

RSEWF.KL=SAMPLE(NORMRN(MSEF.K,SSEF.K),1,MSEF.K)       47, R
MSEF.K=WSRF*EXPF.K                                     48, A
WSRF=0.08                                              48.1, C
SSEF.K=0.01*EXPF.K                                     49, A
TWSEF.K=TWSEF.J+DT*RSEWF.JK                            50, L
TWSEF=BSEWF                                            50.1, N
BSEWF=0                                                50.2, C
    RSEWF  - (W/M) RATE OF ADDITION OF SUCCESSFUL
               EXPLORATORY FARMED OUT WELLS
    MSEF   - (W/M) MEAN VALUE OF RATE OF ADDITION OF
               SUCCESSFUL EXPLORATORY FARMED OUT WELLS
    SSEF   - (W/M) STANDARD DEVIATION OF RATE OF
               ADDITION OF SUCCESSFUL EXPLORATORY FARMED
               OUT WELLS DRILLED
    WSRF   - (1) SUCCESS RATIO OF EXPLORATORY FARMED OUT
               WELLS
    EXPF   - (W/M) RATE OF EXPLORATORY DRILLING OF
               FARMED OUT WELLS
    TWSEF  - (W) CUMULATIVE NUMBER OF SUCCESSFUL
               EXPLORATORY FARMED OUT WELLS
    BSEWF  - (W) BASE VALUE OF CUMULATIVE NUMBER OF
               FARMED OUT WELLS DRILLED SOLELY
```

It is assumed that the rate of addition of successful exploratory farmed out wells (RSEWF, 47) follows a normal distribution with success rate of only 8 percent and standard deviation of 1 percent of the rate of exploratory drilling of farmed out wells. The cumulative number of successful exploratory farmed out wells (TWSEF, 50) is increased by the rate of addition of successful exploratory farmed out wells (RSEWF, 47).

COMPLETION OF WELLS SECTOR

<u>Completion Stage</u>: The equations representing this stage are:

```
 COMPLETION STAGE SECTOR
WRASCS.K=DLINF3(WRSEWS.JK,DECP)                              51, A
WRASCP.K=DLINF3(WRSEWP.JK,DECP)                              52, A
DRASCS.K=DLINF3(DRSEWS.JK,DECP)                              53, A
DRASCP.K=DLINF3(DRSEWP.JK,DECP)                              54, A
DECP=12                                                      54.1, C
RCWS.KL=DRASCS.K+WRASCS.K                                    55, R
RCWP.KL=DRASCP.K+WRASCP.K                                    56, R
RCWF.KL=DELAY3(RSEWF.JK,DECP)                                57, R
RRCWF.KL=DELAY3(RCWF.JK,DEC)                                 58, R
RRCWS.KL=DELAY3(RCWS.JK,DEC)                                 59, R
TCWS.K=TCWS.J+DT*(RCWS.JK-RRCWS.JK)                          60, L
TCWS=2                                                       60.1, N
DEC=24                                                       60.2, C
RRCWP.KL=DELAY3(RCWP.JK,DEC)                                 61, R
TCWP.K=TCWP.J+DT*(RCWP.JK-RRCWP.JK)                          62, L
TCWP=1                                                       62.1, N
    WRASCS - (W/M) START RATE OF COMPLETION OF
                SUCCESSFUL EXPLORATORY WILD CAT WELLS
                DRILLED SOLELY
    WRSEWS - (W/M) RATE OF ADDITION OF SUCCESSFUL
                EXPLORATORY WILD CAT WELLS DRILLED SOLELY
    DECP   - (M) DELAY IN STARTING THE COMPLETION
                PROCESS
    WRASCP - (W/M) START RATE OF COMPLETION OF
                SUCCESSFUL EXPLORATORY WILD CAT WELLS
                DRILLED UNDER PARTNERSHIP
    WRSEWP - (W/M) RATE OF ADDITION OF SUCCESSFUL
                EXPLORATORY WILD CAT WELLS DRILLED UNDER
                PARTNERSHIP
    DRASCS - (W/M) START RATE OF COMPLETION OF
                SUCCESSFUL EXPLORATORY WELLS DRILLED
                SOLELY
    DRSEWS - (W/M) RATE OF ADDITION OF SUCCESSFUL
                EXPLORATORY "DEVELOPMENT" WELLS DRILLED
                SOLELY
    DRASCP - (W/M) START RATE OF COMPLETION OF
                SUCCESSFUL EXPLORATORY WELLS DRILLED
                UNDER PARTNERSHIP
    DRSEWP - (W/M) RATE OF ADDITION OF SUCCESSFUL
                EXPLORATORY "DEVELOPMENT" WELLS DRILLED
                UNDER PARTNERSHIP
    RCWS   - (W/M) START RATE OF COMPLETION OF WELLS
                DRILLED SOLELY
    RCWP   - (W/M) START RATE OF COMPLETION OF WELLS
                DRILLED UNDER PARTNERDHIP
    RCWF   - (W/M) START RATE OF COMPLETION OF FARMED
                OUT WELLS
    RSEWF  - (W/M) RATE OF ADDITION OF SUCCESSFUL
                EXPLORATORY FARMED OUT WELLS
    RRCWF  - (W/M) RATE OF COMPLETION OF ,FARMED OUT
                WELLS
    DEC    - (M) DELAY IN COMPLETING THE WELLS
    RRCWS  - (W/M) RATE OF COMPLETION OF WELLS DRILLED
                SOLELY
    TCWS   - (W) TOTAL WELLS IN THE PROCESS OF
                COMPLETION( DRILLED SOLELY)
    RRCWP  - (W/M) RATE OF COMPLETION OF WELLS DRILLED
                UNDER PARTNERSHIP
    TCWP   - (W) TOTAL WELLS IN THE PROCESS OF
                COMPLETION(DRILLED UNDER PARTNERSHIP)
```

Completion work on the various categories of wells begin after an average delay of 12 months (equations 51, 52, 53, 54). Only those successful exploratory wells will be completed for the purpose of production.

The start rate of completion of wells (drilled solely or under partnership) is simply the addition of start rate of completion of successful exploratory wild-cat wells and development wells (RCWS, 55; RCWP, 56). Farmed-out wells begin after an average delay of 12 months (RCWF, 57, DECP=12). After a further delay of 24 months (DEC=24), the farmed out wells are completed (RRCWF, 58). It is assumed, initially, that two wells are in the process of completion solely by the company and another one in process under partnership agreements.

<u>Producing Wells (wells completed solely by the company):</u> The equations representing this part are:

```
PRODUCING WELLS SECTOR:
COMPLETED SOLELY BY COMPANY

TPWS.K=TPWS.J+DT*(RRCWS.JK-RDPWS.JK)                      63, L
TPWS=4                                                    63.1, N
RDPWS.KL=TPWS.K/AWLS.K                                    64, R
AWLS.K=(URFS*TPRS.K)/STAPS.K                              65, A
URFS=0.8                                                  65.1, C
    TPWS    - (W) TOTAL PRODUCING WELLS(COMPLETED SOLELY)
    RRCWS   - (W/M) RATE OF COMPLETION OF WELLS DRILLED
                SOLELY
    RDPWS   - (W/M) RATE OF DECAY OF PRODUCING WELLS
                COMPLETED SOLELY
    AWLS    - (M) AVE WELL LIFE(OWN SOLELY)
    URFS    - (1) ULTIMATE RECOVERY FACTOR(WELLS DRILLED
                SOLELY)
    TPRS    - (B) TOTAL PROVEN RESERVES FROM WELLS
                COMPLETED SOLELY
    STAPS   - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
                FROM WELLS DRILLED SOLELY
```

The total number of producing wells (completed solely by the company) (TPWS, 63) is increased by the rate of completion of wells (drilled solely) (RRCWS, 59) and depleted by the rate of decay of producing wells (RDPWS, 64). The rate of decay of producing wells (RDPWS, 64) is governed by the total number of producing wells (TPWS, 63) and the average well life (AWLS, 65). The ultimate recovery factor (URFS, 65.1) (assumed to be 80 percent), determines the amount of proven reserves which will be produced. The larger the reserves, the longer will be the average well life. But if the production rate is increased with no corresponding increase in the proven reserves, the average well life will decrease (AWLS, 65). It is assumed, initially, that four producing wells have been completed solely by the company.

<u>Producing Wells Sector (completed under partnership)</u>: The equations representing this part are:

```
 COMPLETED UNDER PARTNERSHIP
TPWP.K=TPWP.J+DT*(RRCWP.JK-RDPWP.JK)                66, L
TPWP=4                                              66.1, N
RDPWP.KL=TPWP.K/AWLP.K                              67, R
AWLP.K=(URFP*TPRP.K)/STAPP.K                        68, A
URFP=0.8                                            68.1, C
    TPWP    - (W) TOTAL PRODUCING WELLS(COMPLETED UNDER
                PARTNERSHIP)
    RRCWP   - (W/M) RATE OF COMPLETION OF WELLS DRILLED
                UNDER PARTNERSHIP
    RDPWP   - (W/M) RATE OF DECAY OF PRODUCING WELLS
                COMPLETED UNDER PARTNERSHIP
    AWLP    - (M) AVE WELL LIFE(SHARING)
    URFP    - (1) ULTIMATE RECOVERY FACTOR(WELLS DRILLED
                UNDER PARTNERSHIP)
    TPRP    - (B) TOTAL PROVEN RESERVES FROM WELLS
                COMPLETED UNDER PARTNERSHIP
    STAPP   - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
                FROM WELLS DRILLED UNDER PARTNERSHIP
```

The logic for equations 66 - 68 is exactly the same as for 63 - 65, except the producing wells are completed under partnership. It is assumed, initially, that four producing wells are 'under partnership'.

<u>Producing Wells (completed under farm out):</u> The equations representing this part are:

```
 COMPLETED UNDER FARM OUT

TPWF.K=TPWF.J+DT*(RRCWF.JK-RDPWF.JK)                    69, L
TPWF=2                                                  69.1, N
RDPWF.KL=TPWF.K/AWLF.K                                  70, R
AWLF.K=(URFF*TPRF.K)/STAPF.K                            71, A
URFF=0.8                                                71.1, C
    TPWF    - (W) TOTAL PRODUCING FARMED OUT WELLS
    RRCWF   - (W/M) RATE OF COMPLETION OF FARMED OUT
                WELLS
    RDPWF   - (W/M) RATE OF DECAY OF PRODUCING FARMED OUT
                WELLS
    AWLF    - (M) AVE WELL LIFE(FARMED OUT WELL)
    URFF    - (1) ULTIMATE RECOVERY FACTOR(FARMED OUT
                WELLS)
    TPRF    - (B) TOTAL PROVEN RESERVES FROM FARMED OUT
                WELLS
    STAPF   - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
                FROM FARMED OUT WELLS
```

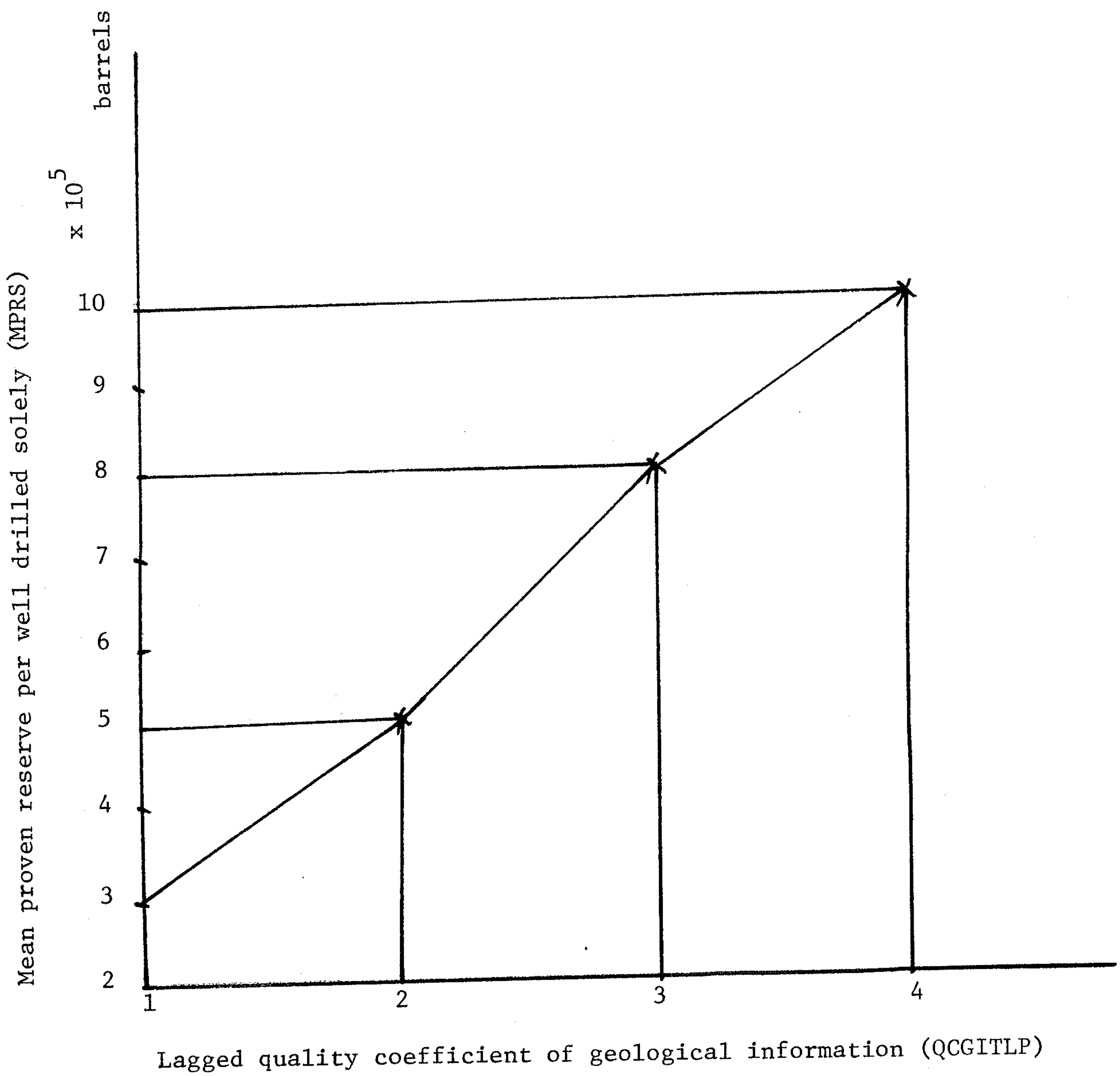
Similarly, equations 69 to 71 follows the same logic as equations 63 to 65, the only difference is that the producing wells are 'farmed-out' wells. It is assumed, initially, that two producing wells are 'farmed-out' wells.

<u>Proven Wells (completed solely by company):</u> The equations representing this part are:

```
 PROVEN WELLS SECTOR:
 COMPLETED BY COMPANY
TPRS.K=TPRS.J+DT*(RPRS.JK-PRS.JK)                              72, L
TPRS=BTPRS                                                     72.1, N
BTPRS=2.8E6                                                    72.2, C
RPRS.KL=APURS.K*RRCWS.JK                                       73, R
APURS.K=SAMPLE(SAPURS.K,12,4E5)                                74, A
SAPURS.K=NORMRN(MPRS.K,SPRS)                                   75, A
MPRS.K=TABHL(TAB7,QCGITLP.K,1,4,1)                             76, A
TAB7=3E5/5E5/8E5/1E6                                           76.1, T
SPRS=8E3                                                       76.2, C
QCGITLP.K=DELAY3(QCGI.K,42)                                    77, A
    TPRS    - (B) TOTAL PROVEN RESERVES FROM WELLS
                COMPLETED SOLELY
    RPRS    - (B/M) RATE OF ADDITION OF PROVEN RESERVES
                TO WELLS DRILLED SOLELY
    PRS     - (B/M) PRODUCTION RATE FROM WELLS COMPLETED
                SOLELY
    BTPRS   - (B) BASE VALUE OF TOTAL PROVEN RESERVES
                FROM WELLS DRILLED SOLELY
    APURS   - (B/W) AVE PROVEN RESERVES PER WELL(SOLELY)
    RRCWS   - (W/M) RATE OF COMPLETION OF WELLS DRILLED
                SOLELY
    SAPURS  - (B/W) SAMPLE VALUE OF AVERAGE PROVEN
                RESERVES PER WELL DRILLED SOLELY
    MPRS    - (B/W) MEAN PROVEN RESERVES PER WELL DRILLED
                SOLELY
    SPRS    - (B/W) STANDARD DEVIATION OF AVERAGE PROVEN
                RESERVES PER WELL DRILLED SOLELY
    TAB7    - (B/W) TABLE GIVING AVERAGE PROVEN RESERVES
                PER WELL DRILLED SOLELY
    QCGITLP- (1) QUALITY COEFFICIENT OF GEOLOGICAL
                INFORMATION AT TIME OF LEASING
    QCGI    - (1) QUALITY COEFFICIENT OF GEOLOGICAL
                INFORMATION
```

The total proven reserves from wells completed solely by the firm (TPRS, 72) is increased by the rate of addition of proven reserves (RPRS, 73) and depleted by the production rate (PRS, 91). It is assumed, initially, that the total proven reserves from wells completed solely by the firm is 2.8 million barrels. The rate of addition of proven reserves (RPRS, 73) is simply the product of the average proven reserves per well (APURS, 74) and the rate of completion of wells (RRCWS, 57). It is assumed that the average proven reserves per well (MPRS, 76) increases as the quality coefficient of geological information at time of leasing (QCGITLP, 77) increases. An element of randomness is added by making the proven reserves per well a normal random function with a standard deviation of 8000 barrels (75, 76.2). The quality coefficient of geological information at time of leasing (QCGITLP, 77) is obtained by lagging the quality coefficient of geological information (QCGI, 3) for 42 months. The relationship between the mean proven reserves per well drilled solely (MPRS, 76) and the quality coefficient at time of leasing (QCGITLP, 77) is given in Fig. 4.3. It is a very simple relationship whereby it is assumed that the higher the quality coefficient of geological information the higher the mean proven reserves per well. The reader is encouraged to explore other relationships utilizing more sophisticated statistical techniques to identify the relationship between the projected reserves per well and the quality coefficient of geological information plus some other quantificable geological information. The actual proven reserves in the model could then be substituted by the projected reserves (probably corrected by some bias errors). For an insightful review of some of these techniques and the potential pitfalls, please refer to the paper by Edward R. Tufte, 1975.

Figure 4.3 Relationship between the lagged quality coefficient of geological information and the mean proven reserves per well drilled solely.



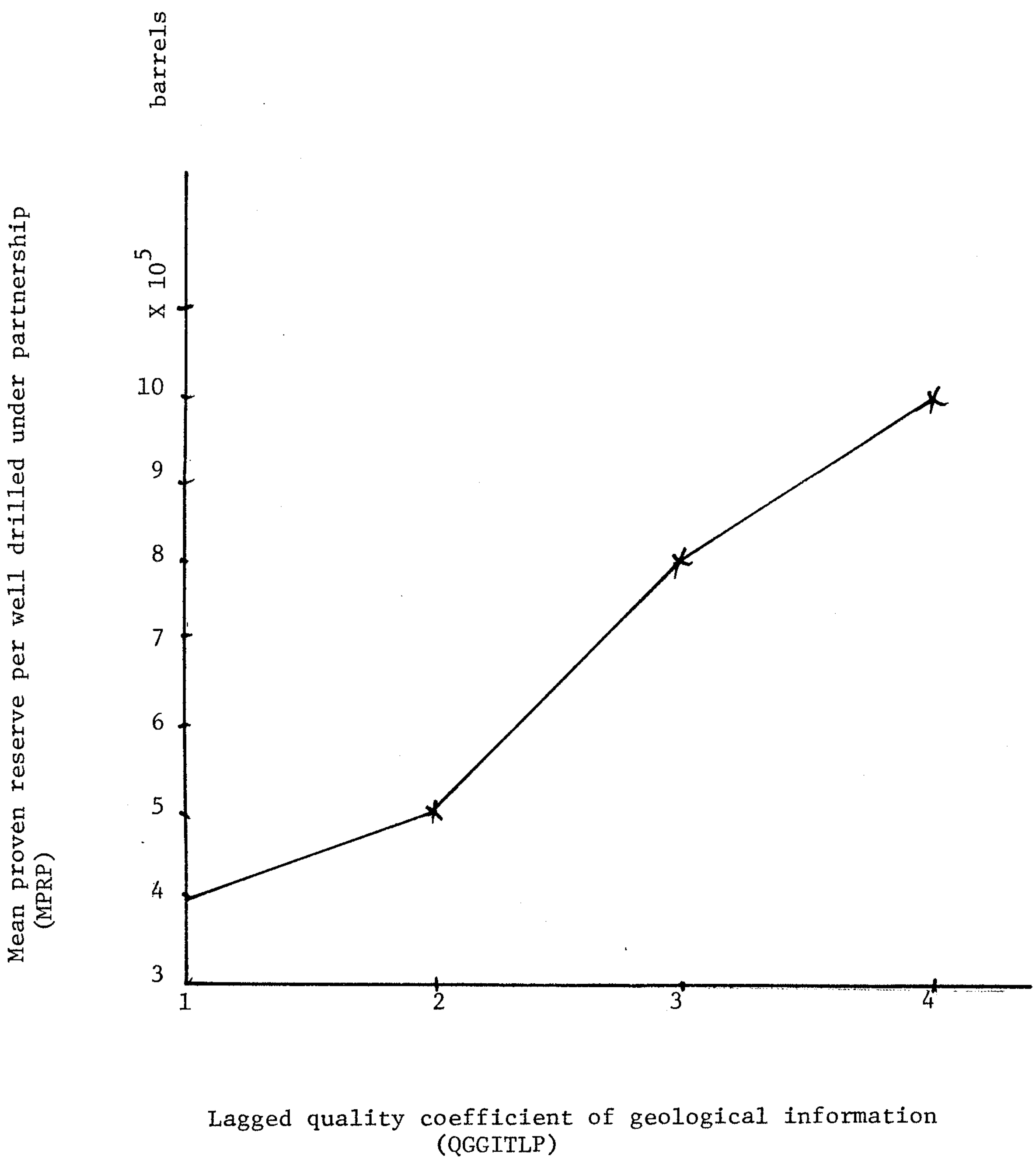
<u>Proven Wells (from wells completed under partnership):</u> The equations representing this part are:

```
 COMPLETED UNDER PARTNERSHIP

TPRP.K=TPRP.J+DT*(RPRP.JK-PRP.JK)                        78, L
TPRP=BTPRP                                               78.1, N
BTPRP=1.5E6                                              78.2, C
RPRP.KL=APURP.K*RRCWP.JK                                 79, R
APURP.K=SAMPLE(SAPURP.K,12,5E5)                          80, A
SAPURP.K=NORMRN(MPRP.K,SPRP)                             81, A
MPRP.K=TABHL(TAB8,QCGITLP.K,1,4,1)                       82, A
TAB8=4E5/5E5/8E5/1E6                                     82.1, T
SPRP=5E3                                                 82.2, C
TPRES.K=TPRS.K+(0.5*TPRP.K)                              83, A
    TPRP    - (B) TOTAL PROVEN RESERVES FROM WELLS
                COMPLETED UNDER PARTNERSHIP
    RPRP    - (B/M) RATE OF ADDITION OF PROVEN RESERVES
                TO WELLS DRILLED UNDER PARTNERSHIP
    PRP     - (B/M) PRODUCTION RATE FROM WELLS COMPLETED
                UNDER PARTNERSHIP
    BTPRP   - (B) BASE VALUE  OF TOTAL PROVEN RESERVES
                FROM WELLS COMPLETED UNDER PARTNERSHIP
    APURP   - (B/W) AVE PROVEN RESERVES PER
                WELL(PARTNERSHIP)
    RRCWP   - (W/M) RATE OF COMPLETION OF WELLS DRILLED
                UNDER PARTNERSHIP
    SAPURP  - (B/W) SAMPLE VALUE OF AVERAGE PROVEN
                RESERVES PER WELL DRILLED UNDER
                PARTNERSHIP
    MPRP    - (B/W) MEAN PROVEN RESERVES PER WELL DRILLED
                UNDER PARTNERSHIP
    SPRP    - (B/W) STANDARD DEVIATION OF AVERAGE PROVEN
                RESERVES PER WELL DRILLED UNDER
                PARTNERSHIP
    TAB8    - (B/W) TABLE GIVING AVERAGE PROVEN RESERVES
                PER WELL DRILLED UNDER PARTNERSHIP
    QCGITLP- (1) QUALITY COEFFICIENT OF GEOLOGICAL
                INFORMATION AT TIME OF LEASING
    TPRES   - (B) TOTAL PROVEN RESERVES
    TPRS    - (B) TOTAL PROVEN RESERVES FROM WELLS
                COMPLETED SOLELY
```

Equations 78 to 83 follows the same logic as in equations 72 to 77, except that the total proven reserves come from wells which are completed under partnership. It is assumed that initially the total proven reserve from wells completed under partnership (TPRP, 78) is 1.5 million barrels. The mean proven reserves per well drilled under partnership (MPRP, 82) is assumed to increase as the lagged quality coefficient of geological information increases (see Fig. 4.4).

Figure 4.4 Relationship between the lagged quality coefficient of geological information and the mean proven reserves per well drilled under partnership.



<u>Proven Wells (from farmed-out wells):</u> The equations representing this part are:

```
 COMPLETED UNDER FARM OUT

APURF.K=SAMPLE(SAPURF.K,12,3E5)                                   84, A
SAPURF.K=NORMRN(MPRF,SPRF)                                        85, A
MPRF=3E5                                                          85.1, C
TPRF.K=TPRF.J+DT*(RPRF.JK-PRF.JK)                                 86, L
TPRF=BTPRF                                                        86.1, N
BTPRF=5E5                                                         86.2, C
RPRF.KL=APURF.K*RRCWF.JK                                          87, R
SPRF=5E4                                                          87.1, C
    APURF   - (B/W) AVE PROVEN RESERVES PER WELL(FARMED
                OUT)
    SAPURF - (B/W) SAMPLE VALUE OF AVERAGE PROVEN
                RESERVES PER FARMED OUT WELL
    MPRF    - (B/W) MEAN PROVEN RESERVES PER FARMED OUT
                WELL
    SPRF    - (B/W) STANDARD DEVIATION OF AVERAGE PROVEN
                RESERVES PER FARMED OUT WELL
    TPRF    - (B) TOTAL PROVEN RESERVES FROM FARMED OUT
                WELLS
    RPRF    - (B/M) RATE OF ADDITION OF PROVEN RESERVES
                TO FARMED OUT WELLS
    PRF     - (B/M) PRODUCTION RATE FROM FARMED OUT WELLS
    BTPRF   - (B) BASE VALUE OF TOTAL PROVEN RESERVES
                FROM FARMED OUT WELLS
    RRCWF   - (W/M) RATE OF COMPLETION OF FARMED OUT
                WELLS
```

The logic for equations 84 to 87 is exactly the same as equations 72 to 77, except that the average proven reserve per farmed-out well (APURF, 84) is assumed to follow a normal distribution with mean (MPRF) of 300,000 barrels and standard deviation (SPRF) of 50,000 barrels. It is also assumed that initially the total proven reserves from farmed-out wells is 500,000 barrels.

Production Capacity (wells completed solely by the company): The equations representing this part are:

```
PRODUCTION CAPACITY SECTOR
WELL COMPLETED SOLELY BY COMPANY

RCPS.K=RRCWS.JK*NPRPWS                                  88, A
NPRPWS=3500                                             88.1, C
    RCPS   - (B/M**2) RATE OF ADDITION OF PRODUCTION
               CAPACITY TO WELLS DRILLED SOLELY
    RRCWS  - (W/M) RATE OF COMPLETION OF WELLS DRILLED
               SOLELY
    NPRPWS - (B/W/M) NORMAL VALUE OF DESIRED PRODUCTION
               RATE PER WELL COMPLETED SOLELY
```

The rate of addition of production capacity to wells drilled solely (RCPS, 88) is simply the product of the rate of completion of wells drilled solely (RRCWS, 59) and the normal value of the desired production rate per well completed solely (NPRPWS). The normal value of the desired production rate per well completed solely (NPRPWS) is assumed to be 3500 barrels per well per month.

<u>Production Capacity Sector (wells completed under partnership)</u>: The equations representing this part are:

```
WELLS COMPLETED UNDER PARTNERSHIP
                                                              89, A
RCPP.K=RRCWP.JK*NPRPWP                                        89.1, C
NPRPWP=3500
    RCPP    - (B/M**2) RATE OF ADDITION OF PRODUCTION
                CAPACITY TO WELLS DRILLED UNDER
                PARTNERSHIP
    RRCWP   - (W/M) RATE OF COMPLETION OF WELLS DRILLED
                UNDER PARTNERSHIP
    NPRPWP  - (B/W/M) NORMAL VALUE OF DESIRED PRODUCTION
                RATE PER WELL COMPLETED UNDER PARTNERSHIP
```

Equation 89 follows the same logic as in equation 88 except that the production capacity comes from wells completed under partnership.

<u>Production Capacity (completed under farm-out)</u>: The equations representing this part are:

```
 WELLS COMPLETED UNDER FARM OUT
                                                          90, A
RCPF.K=RRCWF.JK*NPRPWF                                    90.1, C
NPRPWF=3000
    RCPF    - (B/M**2) RATE OF ADDITION OF PRODUCTION
                CAPACITY TO FARMED OUT WELLS
    RRCWF   - (W/M) RATE OF COMPLETION OF FARMED OUT
                WELLS
```

Equation 90 follows the same logic as in equation 88 except that the production capacity comes from wells completed under farm-out and the normal value of the desired production rate per well completed under farm-out is assumed to be 3,000 barrels per well per month.

PRODUCTION SECTOR

The equations representing this sector are:

```
PRODUCTION SECTOR

PRS.KL=TPWS.K*ALP.K*MPRPW.K                                    91, R
PRP.KL=TPWP.K*ALP.K*MPRPW.K                                    92, R
PRF.KL=TPWF.K*ALP.K*MPRPW.K                                    93, R
ALP.K=IALP+STEP(CIALP,120)                                     94, A
IALP=3.5E3                                                     94.1, C
CIALP=0                                                        94.2, C
MPRPW.K=TABHL(TPRPW,RCCL.K,0.2,1.4,0.4)                        95, A
TPRPW=0.8/.9/1/1                                               95.1, T
    PRS     - (B/M) PRODUCTION RATE FROM WELLS COMPLETED
                SOLELY
    TPWS    - (W) TOTAL PRODUCING WELLS(COMPLETED SOLELY)
    ALP     - (B/M/W) MAX ALLOWABLE RATE OF PRODUCTION
    MPRPW   - (1) TABLE GIVING MULTIPLIER FOR RATE OF
                PRODUCTION CAPACITY ADDITION
    PRP     - (B/M) PRODUCTION RATE FROM WELLS COMPLETED
                UNDER PARTNERSHIP
    TPWP    - (W) TOTAL PRODUCING WELLS(COMPLETED UNDER
                PARTNERSHIP)
    PRF     - (B/M) PRODUCTION RATE FROM FARMED OUT WELLS
    TPWF    - (W) TOTAL PRODUCING FARMED OUT WELLS
    IALP    - (B/W/M) INITIAL VALUE OF ALLOWABLE RATE OF
                PRODUCTION
    TPRPW   - (1) TABLE GIVING MULTIPLIERS FOR DESIRED
                PRODUCTION RATE PER WELL PER MONTH
    RCCL    - (1) RATIO OF ACTUAL COMPANY'S LIFE TO
                COMPANY'S DESIRED LIFE HORIZO
```

The production rate for wells completed solely by the firm (PRS, 91) is a product of the total number of producing wells completed solely (TPWS, 63), the maximum allowable rate of production (ALP, 94) and is scaled up and down by a multiplier (MPRPW, 95) which depends on the ratio of the company's actual life horizon to the company's desired life horizon (RCCL, 166). The higher the ratio, the bigger will be the multiplier. The relationship between the ratio (RCCL) and the multiplier (MPRPW) is given as:

Ratio: $\frac{\text{Company actual life horizon}}{\text{Company desired life horizon}}$	0.2	0.6	1	1.4
Multiplier for rate of production capacity addition	0.8	0.9	1	1

This relationship can be interpreted as the company's managerial policy to reduce production in reaction to falling reserves to avoid the catastrophe of running dry. Any other relationship could be used to reflect the different policies which the company can adopt. The same logic applies to the production rate for wells completed under partnership (PRP, 92), and the production rate for farmed out wells (PRF, 93).

The allowable rate of production (ALP, 94) is specified by the principal regulatory bodies. The stated purpose of controlling the rate of production, also known as "provationing", is to prevent waste of petroleum by ensuring that the firm produces oil at an efficient rate; thereby conserving reservoir energy and maximizing the ultimate amount recovered. The amount of the allowable rate that a well will be assigned is a composite of two things: (1) physical characteristics of the reservoir and (2) current supply and demand conditions. For simplicity, this model assumes an initial allowable rate of 3500 barrels per well per month.

<u>Short and long term average production rate</u>: The equations to compute the averages are:

```
SHORT & LONG TERM AVERAGE PORDUCTION RATES
STAPS.K=STAPS.J+(DT/STAS)*(PRS.JK-STAPS.J)          96, L
STAPS=TPWS*NPRPWS                                   96.1, N
STAS=6                                              96.2, C
STAPP.K=STAPP.J+(DT/STAP)*(PRP.JK-STAPP.J)          97, L
STAPP=TPWP*NPRPWP                                   97.1, N
STAP=6                                              97.2, C
STAPF.K=STAPF.J+(DT/STAF)*(PRF.JK-STAPF.J)          98, L
STAPF=TPWF*NPRPWF                                   98.1, N
STAF=6                                              98.2, C
LAPRS.K=LAPRS.J+(DT/LTAS)*(PRS.JK-LAPRS.J)          99, L
LTAS=24                                             99.1, C
LAPRS=STAPS                                         99.2, N
LAPRP.K=LAPRP.J+(DT/LTAS)*(PRP.JK-LAPRP.J)          100, L
LAPRP=STAPP                                         100.1, N
    STAPS   - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
                FROM WELLS DRILLED SOLELY
    STAS    - (M) SMOOTHING FACTOR OF SHORT TERM AVERAGE
                PRODUCTION RATE FOR WELLS DRILLED SOLELY
    PRS     - (B/M) PRODUCTION RATE FROM WELLS COMPLETED
                SOLELY
    TPWS    - (W) TOTAL PRODUCING WELLS(COMPLETED SOLELY)
    NPRPWS  - (B/W/M) NORMAL VALUE OF DESIRED PRODUCTION
                RATE PER WELL COMPLETED SOLELY
    STAPP   - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
                FROM WELLS DRILLED UNDER PARTNERSHIP
    STAP    - (M) SMOOTHING FACTOR OF SHORT TERM AVERAGE
                PRODUCTION RATE FOR WELLS DRILLED UNDER
                PARTNERSHIP
    PRP     - (B/M) PRODUCTION RATE FROM WELLS COMPLETED
                UNDER PARTNERSHIP
    TPWP    - (W) TOTAL PRODUCING WELLS(COMPLETED UNDER
                PARTNERSHIP)
    NPRPWP  - (B/W/M) NORMAL VALUE OF DESIRED PRODUCTION
                RATE PER WELL COMPLETED UNDER PARTNERSHIP
    STAPF   - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
                FROM FARMED OUT WELLS
    STAF    - (M) SMOOTHING FACTOR OF SHORT TERM AVERAGE
                PRODUCTION RATE FOR FARMED WELLS
    PRF     - (B/M) PRODUCTION RATE FROM FARMED OUT WELLS
    TPWF    - (W) TOTAL PRODUCING FARMED OUT WELLS
    LAPRS   - (B/M) LONG TERM AVERAGE PRODUCTION RATE
                FROM WELLS COMPLETED SOLELY
    LTAS    - (M) LONG TERM PRODUCTION AVERAGING TIME
    LAPRP   - (B/M) LONG TERM AVERAGE PRODUCTION RATE
                FROM WELLS COMPLETED UNDER PARTNERSHIP
```

This section calculates the average production rate for the past six months and long term average production rate for the last 2 years using exponential smoothing functions. The short term average production rate from wells drilled solely (STAPS, 96), under partnership (STAPP, 97) and farmed-out (STAPF, 98) are computed. Similarly the long term average production rate for wells drilled solely (LAPRS, 99), and under partnership (LAPRP, 100) are computed.

FINANCIAL ACCOUNTING SECTOR

Price per barrel and cost of production assumptions: The equations representing this part are:

```
  ** FINANCIAL ACCOUNTING SECTOR **
  PRICE PER BARREL AND COST OF PRODUCTION
   ASSUMPTIONS

PPB.K=PPB.J+DT*(PCIF.JK*PB)                                101, L
PPB=PB                                                     101.1, N
PB=18                                                      101.2, C
PCIF.KL=PULSE(IPIF/DT,FP,IVL)                              102, R
IPIF=0.                                                    102.1, C
IVL=1000                                                   102.2, C
FP=120                                                     102.3, C
PCPB.K=SAMPLE(SPCPB.K,12,2)                                103, A
SPCPB.K=SPCPB.J+DT*(CIF.JK*CPB)                            104, L
SPCPB=CPB                                                  104.1, N
CPB=2                                                      104.2, C
    PPB     - ($/B) PRICE PER BARREL
    PCIF    - (1) RATIO REFLECTING RATE OF PRICE INCREASE
    PB      - ($/B) BASE VALUE OF PRICE PER BARREL
    IPIF    - (1) PRICE INFLATION FACTOR
    PCPB    - ($/B) PRODUCTION COST PER BARREL
    SPCPB   - ($/B) COST OF PRODUCTION PER BARREL
    CIF     - (1) COST INFLATION FACTOR
    CPB     - ($/B) INITIAL PRODUCTION COST PER BARREL AT
                THE END OF THE YEAR
```

The price per barrel (PPB, 101) is initially assumed to be 18 dollars per barrel. Production cost (PCPB, 103) is initially assumed to be two dollars per barrel. The production cost includes only lifting and transportation cost. Experimental inputs (PCIF, 102; CIF, 110) are included to allow prices and costs to be increased.

<u>Exploration and development cost (wells drilled solely by company):</u> The equations representing this part are:

```
 EXPLORATION AND DEVELOPMENT COST:
 WELLS DRILLED SOLELY BY COMPANY

ACEPWS.K=SAMPLE(SACES.K,12,3.5E5)                       105, A
SACES.K=ECPEWS.K+DAEWS.K                                106, A
DAEWS.K=3E4                                             107, A
ECPEWS.K=SAMPLE(NORMRN(MECS.K,SECS),12,MECS.K)          108, A
SECS=1E4                                                108.1, C
MECS.K=MECS.J+DT*(CIF.JK*CES)                           109, L
MECS=CES                                                109.1, N
CES=3E5                                                 109.2, C
CIF.KL=PULSE(ICIF/DT,12,12)                             110, R
ICIF=0.                                                 110.1, C
ACDPWS.K=SAMPLE(SADES.K,12,3E5)                         111, A
SADES.K=NORMRN(1.5,0.1)*ACEPWS.K                        112, A
    ACEPWS - ($/W) AVE COST OF EXPLORATION PER
                WELL(SHARING)
    SACES  - ($/W) SAMPLE VALUE OF ACERAGE COST OF
                EXPLORATION PER WELL DRILLED SOLELY
    ECPEWS - ($/W) ESTIMATED COST OF EXPLORATION PER
                WELL TO BE DRILLED SOLELY
    DAEWS  - ($/W) DEVIATION OF ACTUAL COST OF
                EXPLORATION PER WELL FROM ESTIMATED COST
                OF EXPLORATION PER WELL
    MECS   - ($/W) MEAN VALUE OF ESTIMATED COST OF
                EXPLORATION PER WELL DRILLED SOLELY
    SECS   - ($/W) STANDARD DEVIATION OF ESTIMATED COST
                OF EXPLORATION PER WELL DRILLED SOLELY
    CIF    - (1) COST INFLATION FACTOR
    CES    - ($/W) BASE VALUE OF COST OF EXPLORATION PER
                WELL SOLELY
    ICIF   - (1) COST INFLATION FACTOR
    ACDPWS - ($/W) AVE COST OF DEVELOPMENT PER
                WELL(DRILLED SOLELY)
    SADES  - ($/W) SAMPLE VALUE OF AVERAGE COST OF
                DEVELOPMENT PER WELL DRILLED SOLELY
```

The exploration cost per well includes (1) expenses incurred in obtaining geological and geophysical information prior to drilling a well, and (2) drilling costs in developing the well. The development cost per well are those incurred to bring the petroleum to the surface, such as casing, oil strings, christmas trees and etc.

It is assumed that the average cost of exploration per well (ACEPWS, 105) is the sum of a fixed cost associated with the procurement of geological information (DAEWS, 107) (Note: DAEWS can easily be made into a variable) and the estimated cost of exploration per well (ECPEWS, 108). The estimated cost of exploration per well (ECPEWS, 108) is assumed to follow a normal random distribution with mean of 300,000 dollars and standard deviation of 10,000 dollars. The model also assumes that the development cost per well (ACDPWS, 111) is a variable proportion of the exploration cost per well (ACEPWS, 105). The proportion is represented by a normal random distribution with a mean of 1.5 and standard deviation of 0.1. These figures were obtained from interviews with professors in the department of Earth Science and the Natural Resource Institute of the University of Manitoba, annual reports of a few oil companies, and publications by the Canadian Government. They are typical figures for wells developed under conventional methods as of 1980.

<u>Exploration and Development Cost (wells drilled under partnership):</u> The equations representing this part are:

```
 WELLS DRILLED UNDER PARTNERSHIP

ACEPWP.K=SAMPLE(SACEP.K,12,5E5)                          113, A
SACEP.K=ECPEWP.K+DAEWS.K                                 114, A
ECPEWP.K=SAMPLE(NORMRN(MECP.K,SECP),12,MECP.K)           115, A
SECP=3E4                                                 115.1, C
MECP.K=MECP.J+DT*(CIF.JK*CEP)                            116, L
MECP=CEP                                                 116.1, N
CEP=5E5                                                  116.2, C
ACDPWP.K=SAMPLE(SADEP.K,12,5E5)                          117, A
SADEP.K=NORMRN(1.5,O.1)*ACEPWP.K                         118, A
    ACEPWP - ($/W) AVE COST OF EXPLORATION PER
               WELL(SOLELY)
    SACEP  - ($/W) SAMPLE VALUE OF AVERAGE COST OF
               EXPLORATION PER WELL DRILLED UNDER
               PARTNERSHIP
    ECPEWP - ($/W) ESTIMATED COST OF EXPLORATION PER
               WELL TO BE DRILLED UNDER PARTNERSHIP
    DAEWS  - ($/W) DEVIATION OF ACTUAL COST OF
               EXPLORATION PER WELL FROM ESTIMATED COST
               OF EXPLORATION PER WELL
    MECP   - ($/W) MEAN VALUE OF ESTIMATED COST OF
               EXPLORATION PER WELL DRILLED UNDER
               PARTNERSHIP
    SECP   - ($/W) STANDARD DEVIATION OF ESTIMATED COST
               OF EXPLORATION PER WELL DRILLED UNDER
               PARTNERSHIP
    CIF    - (1) COST INFLATION FACTOR
    CEP    - ($/W) BASE VALUE OF MEAN VALUE OF COST OF
               EXPLORATION PER WELL DRILLED UNDER
               PARTNERSHIP
    ACDPWP - ($/W) AVE COST OF DEVELOPMENT PER WELL(
               SHARING)
    SADEP  - ($/W) SAMPLE VALUE OF AVERAGE COST OF
               DEVELOPMENT PER WELL DRILLED UNDER
               PARTNERSHIP
```

The logic for equations 113 to 118 is exactly the same as in equations 105 to 112, except that the wells are drilled under partnership.

<u>Operating Revenue</u>: The equations representing this part are:

```
 OPERATING REVENUE

TSRS.K=PPB.K*STAPS.K                                        119, A
TSRP.K=PPB.K*STAPP.K*0.5                                    120, A
TSRF.K=FF*PPB.K*STAPF.K                                     121, A
FF=.12                                                      121.1, C
TSALE.K=TSALE.J+DT*(RSALE.JK-CBSALE.JK)                     122, L
TSALE=0                                                     122.1, N
CBSALE.KL=PULSE(TSALE.K/DT,12,12)                           123, R
TSALER.K=SAMPLE(TSALE.K,12,4E6)                             124, A
RSALE.KL=TSRS.K+TSRP.K+TSRF.K                               125, R
    TSRS   - ($/M) SALES REVENUE RECEIVED FROM WELLS
               DRILLED SOLELY
    PPB    - ($/B) PRICE PER BARREL
    STAPS  - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
               FROM WELLS DRILLED SOLELY
    TSRP   - ($/M) SALES REVENUE RECEIVED FROM WELLS
               DRILLED UNDER PARTNERSHIP
    STAPP  - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
               FROM WELLS DRILLED UNDER PARTNERSHIP
    TSRF   - ($/M) SALES REVENUE PROCEEDING TO THE
               COMPANY FROM FARMED OUT WELLS
    FF     - (1) PROPORTION OF SALES REVENUE FROM FARMED
               OUT WELLS
    STAPF  - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
               FROM FARMED OUT WELLS
    TSALE  - $) TOTAL SALES REVENUE
    RSALE  - ($/M) RATE OF SALES REVENUE RECEIVED PER
               MONTH
    CBSALE - ($/Y) CLOSING BALANCE FOR SALES REVENUE
    TSALER - ($/Y) TOTAL SALES REVENUE REPORTED
```

The sales revenue per month received from producing wells drilled solely (TSRS, 119) is the product of the price per barrel (PPB, 101) and the short term average production rate from wells drilled solely (STAPS, 96).

As mentioned previously, the model assume a 50-50 partnership where the cost of drilling and income are equally shared. As such, the sales revenue received from wells drilled under partnership (TSRP, 120) is simply the product of price per barrel (PPB, 101), the short term average production rate from wells drilled under partnership (STAPP, 97) and 0.5. For farmed-out wells, the model assumes that 12% (FF=0.12) of the sales revenue received from farmed-out wells goes to the company (i.e., the total sales revenue going to the company from farmed-out wells (TSRF, 121) is the product of the price per barrel (PPB, 101), the short term average production rate from farmed-out wells (STAPF, 98) and 0.12).

The total sales revenue (TSALE, 122) is increased by the rate of sales revenue received per month (RSALE, 125) until the end of the year where it is then set to zero by the closing balance for sales revenue (CBSALE, 123). The rate of sales revenue received per month (RSALE, 125) is simply the sum of the sales revenue received per month from wells drilled solely (TSRS, 119), the sales revenue received per month from wells drilled under partnership (TSRP, 120) and the sales revenue proceeding to the company from farmed-out wells (TSRF, 121).

Operating expenses: The equations representing operating expenses are:

```
OPERATING EXPENSES

RCP.KL=PCPB.K*(STAPS.K+0.5*STAPP.K)                        126, R
RCES.KL=ACEPWS.K*RCWES.JK                                  127, R
RCEP.KL=ACEPWP.K*RCWEP.JK                                  128, R
RCCS.KL=ACDPWS.K*RRCWS.JK                                  129, R
RCCP.KL=ACDPWP.K*RRCWP.JK                                  130, R
GAEXR.KL=FRSGA*RSALE.JK                                    131, R
FRSGA=0.05                                                 131.1, C
TEXP.K=TEXP.J+DT*(RCP.JK+RCES.JK+RCCS.JK+0.5*              132, L
  (RCEP.JK+RCCP.JK)+TRP.JK+DDFL.JK+RCL.JK+GAEXR.JK+
  RSPCPS.JK+0.5*RSPCPP.JK-CEXP.JK)
TEXP=0                                                     132.2, N
TEXPR.K=SAMPLE(TEXP.K,12,3E6)                              133, A
CEXP.KL=PULSE(TEXP.K/DT,12,12)                             134, R
PBT.K=TSALER.K-TEXPR.K                                     135, A
ATP.K=CLIP((1-TAX)*PBT.K,PBT.K,PBT.K,0)                    136, A
TAX=0.4                                                    136.1, C
RCL.KL=RLHOL.K*SMOOTH(ACPA.K,12)                           137, R
TRP.KL=RORP*RSALE.JK                                       138, R
RORP=0.15                                                  138.1, C
    RCP    - ($/M) COST OF PRODUCTION PER MONTH
    PCPB   - ($/B) PRODUCTION COST PER BARREL
    STAPS  - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
               FROM WELLS DRILLED SOLELY
    STAPP  - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
               FROM WELLS DRILLED UNDER PARTNERSHIP
    RCES   - ($/M) COST OF EXPLORATION(WELLS DRILLED
               SOLELY)
    ACEPWS - ($/W) AVE COST OF EXPLORATION PER
               WELL(SHARING)
    RCWES  - (W/M) RATE OF COMPLETION OF EXPLORATORY
               DRILLING(WELLS DRILLED SOLELY
    RCEP   - ($/M) COST OF EXPLORATION(WELLS DRILLED
               UNDER PARTNERSHIP)
    ACEPWP - ($/W) AVE COST OF EXPLORATION PER
               WELL(SOLELY)
    RCWEP  - (W/M) RATE OF COMPLETION OF EXPLORATORY
               DRILLING(WELLS DRILLED UNDER PARTNERSHIP
    RCCS   - ($/M) COST OF COMPLETION(WELLS DRILLED
               SOLELY)
    ACDPWS - ($/W) AVE COST OF DEVELOPMENT PER
               WELL(DRILLED SOLELY)
    RRCWS  - (W/M) RATE OF COMPLETION OF WELLS DRILLED
               SOLELY
    RCCP   - ($/M) COST OF COMPLETION(WELLS DRILLED
               UNDER PARTNERSHIP)
    ACDPWP - ($/W) AVE COST OF DEVELOPMENT PER WELL(
               SHARING)
    RRCWP  - (W/M) RATE OF COMPLETION OF WELLS DRILLED
               UNDER PARTNERSHIP
    GAEXR  - ($/M) GENERAL AND ADMINISTRATION EXPENSES
               RATE
    FRSGA  - (1) FRACTION CHARGED TO GENERAL AND
               ADMINISTRATION EXPENSES
    RSALE  - ($/M) RATE OF SALES REVENUE RECEIVED PER
               MONTH
    TEXP   - ($) TOTAL EXPENDITURE
    TRP    - ($/M) ROYALTY PAYMENTS
    DDFL   - ($/M) DEPRECIATION AND DEPLETION CASH FLOW
               PER MONTH
    RCL    - ($/M) COST OF ACREAGE
    RSPCPS - ($/M**2) RATE OF ADDITION OF INVESTMENT TO
               PRODUCTION CAPACITY OF WELLS DRILLED
               SOLELY
    RSPCPP - ($/M**2) RATE OF ADDITION OF INVESTMENT TO
               PRODUCTION CAPACITY OF WELLS DRILLED
               UNDER PARTNERSHIP
    CEXP   - ($/Y) CLOSING BALANCE FOR EXPENDITURE
    TEXPR  - ($/Y) TOTAL EXPENDITURE REPORTED
    PBT    - ($/Y) PROFIT BEFORE TAX
    TSALER - ($/Y) TOTAL SALES REVENUE REPORTED
    ATP    - ($/Y) AFTER TAX PROFIT
    TAX    - (1) TAX RATE
    RLHOL  - (ACRES) AMOUNT OF RAW LAND HOLDINGS
    ACPA   - ($/ACRE/M) AVE COST OF ACREAGE
    RORP   - (1) RATE OF ROYALTY PAYMENTS
```

The total cost of production per month (RCP, 126) is the addition of the cost of production from wells drilled solely and the production cost of production from wells drilled under partnership. The cost of production from wells drilled solely is the product of the production cost per barrel (PCPB, 103) and the short term average production rate from wells drilled solely (STAPS, 96). The cost of production from wells drilled under partnership is the product of the production cost per barrel (PCPB, 103), the short term average production rate from wells drilled under partnership (STAPP, 97) and 0.5 (since the cost of production is shared equally under the partnership agreement).

The cost of exploration of wells drilled solely (RCES, 127) is the product of the average cost of exploration per well drilled solely (ACEPWS, 105) and the rate of completion of exploratory wells drilled solely (RCWES, 22). The cost of exploration for wells drilled under partnership (RCEP, 128) follows the same logic.

The cost of completion for wells drilled solely (RCCS, 129) is the product of the cost of development per well for wells drilled solely (ACDPWS, 111) and the rate of completion of wells drilled solely (RRCWS, 59). The cost of completion of wells (drilled under partnership) (RCCP, 130) follows the same logic.

It is also assumed that the general and administrative expenses per month (GAEXR, 131) is a fixed percentage (FRSGA=0.05) of the sales revenue per month (RSALE, 125).

The total expenditure (TEXP, 132) includes: (1) production cost (RCP, 126), (2) exploration cost for wells drilled solely (RCES, 127), (3) completion cost for wells drilled solely (RCCS, 129), (4) 50% of the cost of exploration for wells drilled under partnership (RCEP, 128) and the cost of completion for wells drilled under partnership (RCCP, 130), (5) royalty payments (TRP, 138), (6) depreciation and depletion cash flow (DDFL, 139), (7) cost of leased acreage (RCL, 137), (8) general and administrative expenses (GAEXR, 131), (9) investment in production capacity addition for wells drilled solely (RSPCPS, 152), and (10) 50% of the investment in production capacity addition for wells drilled under partnership (RSPCPP, 156).

The end of the year expenditure (TEXPR, 133) is computed from this. The profit before tax (PBT, 135) is simply the difference between the total sales revenue per year (TSALER, 124) and the total expenditure per year (TEXPR, 133). After tax profit (ATP, 136) is assumed to be 60 percent of the profit before tax (i.e., a 40 percent corporate profit tax).

The cost of leased acreage per month (RCL, 137) is the product of the amount of raw land holdings (RLHOL, 6) and the average cost to lease an acre (ACPA, 2) smoothed out over the past 12 months. The royalty payments per month (TRP, 138) is a straight landowners royalty. It entitles its owner to receive a certain proportion of the value of production from a lease, free from any expense of operation. In this model the royalty is assumed to be 15 percent.

<u>Depreciation and depletion charges:</u> The equations to represent these are:

```
 DEPRECIATION AND DEPLETION

DDFL.KL=DECFL.JK+DPCFL.JK                                  139, R
CFLOW.K=ATP.K+TDFLR.K                                      140, A
TDDFL.K=TDDFL.J+DT*(DECFL.JK+DPCFL.JK-CBDFL.JK)            141, L
TDDFL=0                                                    141.1, N
TDFLR.K=SAMPLE(TDDFL.K,12,96E3)                            142, A
CBDFL.KL=PULSE(TDDFL.K/DT,12,12)                           143, R
DECFL.KL=DECFLS.JK+0.5*DECFLP.JK                           144, R
DPCFL.KL=DPCFLS.JK+0.5*DPCFLP.JK                           145, R
DECFLS.KL=CAPIPS.K/AWLS.K                                  146, R
DECFLP.KL=CAPIPP.K/AWLP.K                                  147, R
DPCFLS.KL=(DINVS.K/TPRS.K)*STAPS.K                         148, R
DPCFLP.KL=(DINVP.K/TPRP.K)*STAPP.K                         149, R
    DDFL    - ($/M) DEPRECIATION AND DEPLETION CASH FLOW
                PER MONTH
    DECFL   - ($/M) DEPRECIATION CASH FLOW
    DPCFL   - ($/M) DEPLETION CASH FLOW PER MONTH
    CFLOW   - ($/Y) CASH FLOW
    ATP     - ($/Y) AFTER TAX PROFIT
    TDFLR   - ($/Y) DEPRECIATION AND DEPLETION CASH FLOW
                REPORTED
    TDDFL   - ($) TOTAL DEPRECIATION AND DEPLETION CASH
                FLOW
    CBDFL   - ($/Y) CLOSING BALANCE FOR DEPRECIATION AND
                DEPLETION CASH FLOW
    DECFLS - ($/M) DEPRECIATION CASH FLOW FROM WELLS
                DRILLED SOLELY
    DECFLP - $/M) DEPRECIATION CASH FLOW FROM WELLS
                DRILLED UNDER PARTNERSHIP
    DPCFLS - ($/M) DEPLETION CASH FLOW PER MONTH FROM
                WELLS DRILLED SOLELY TO WELLS DRILLED
                SOLELY
    DPCFLP - ($/M) DEPLETION CASH FLOW PER MONTH FROM
                WELLS DRILLED UNDER PARTNERSHIP
    CAPIPS - ($) CAPITAL INVESTMNT ON PRODUCTION
                CAPACITY FROM WELLS DRILLED SOLELY
    AWLS    - (M) AVE WELL LIFE(OWN SOLELY)
    CAPIPP - ($) CAPITAL INVESTMENT ON PRODUCTION
                CAPACITY FROM WELLS DRILLED UNDER
                PARTNERSHIP
    AWLP    - (M) AVE WELL LIFE(SHARING)
    DINVS   - ($) CAPITAL INVESTMENT ON DEVELOPING THE
                WELLS DRILLED SOLELY
    TPRS    - (B) TOTAL PROVEN RESERVES FROM WELLS
                COMPLETED SOLELY
    STAPS   - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
                FROM WELLS DRILLED SOLELY
    DINVP   - ($) CAPITAL INVESTMENT ON DEVELOPING THE
                WELLS DRILLED UNDER PARTNERSHIP
    TPRP    - (B) TOTAL PROVEN RESERVES FROM WELLS
                COMPLETED UNDER PARTNERSHIP
    STAPP   - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
                FROM WELLS DRILLED UNDER PARTNERSHIP
```

Depreciation and depletion cash flow per month (DDFL, 139) are calculated from wells completed solely by the firm and under partnership. In this model a straight line depreciation technique is adopted to calculate the depreciation cash flow from wells drilled solely (DECFLS, 146) and depreciation cash flow from wells drilled under partnership (DECFLP, 147). In other words, an equal portion of the cost of the asset is allocated to each period of use (i.e., the depreciation cash flow is simply the ratio of the capital investment on production capacity (CAPIPS, 151 and CAPIPP, 155) to the average well life; AWLS, 65 and AWLP, 68.

Natural resource such as mineral and oil are sometimes called wasting assets. Depletion is the gradual exhaustion of the original amounts of the resources required. Depletion differs from depreciation because the former focuses narrowly on a physical phenomenon and the latter focus more broadly on any cause of the reduction of the economic value of a fixed asset. The investment in natural resources may be likened to a lump sum acquisition of massive quantities of inventories under the ground (oil). Depletion is the measure of that portion "long term inventory" that is used up in a particular period. For example, a well, that cost $20 million and originally contained an estimated one million barrels of oil, has a depletion rate of $20 per barrel. In this context, the depletion cash flow for wells drilled solely (DPCFLS, 148) is the ratio of the capital investment on developing the wells drilled solely (DINVS, 157) to the total proven reserves from wells completed solely (TPRS, 72) multiplied by the short term average production rate from wells drilled solely (STAPS, 96). The depletion cash flow for wells drilled under partnership (DPCFLP, 149) follows the same logic.

FINANCIAL PERFORMANCE SECTOR

Return on investment: The equation representing this performance measure is:

```
** INVESTMENT FLOWS AND FINANCIAL PERFORMANCE
 SECTOR **
RETURN ON INVESTMENT

ROI.K=(ATP.K*100)/TASSET.K                          150, A
    ROI    - (%/Y) RETURN ON INVESTMENT
    ATP    - ($/Y) AFTER TAX PROFIT
    TASSET - ($) TOTAL ASSETS
```

After tax return on investment (ROI, 150) is simply the ratio of after tax profit (ATP, 136) to the total assets of the company (TASSET, 161), expressed as a percentage.

<u>Investment in development wells (production capacity):</u> The equations representing this investment are:

```
 INVESTMENT IN DEVELOPMENT WELLS

CAPIPS.K=CAPIPS.J+DT*(RSPCPS.JK-DECFLS.JK)          151, L
CAPIPS=BCAPIS                                       151.1, N
BCAPIS=12E4                                         151.2, C
RSPCPS.KL=RCPS.K*CAPCAP.K                           152, R
CAPCAP.K=SAMPLE(SCAP.K,12,20)                       153, A
SCAP.K=SCAP.J+DT*(CIF.JK*ISCAP)                     154, L
SCAP=ISCAP                                          154.1, N
ISCAP=20                                            154.2, C
CAPIPP.K=CAPIPP.J+DT*(RSPCPP.JK-DECFLP.JK)          155, L
CAPIPP=BCAPIP                                       155.1, N
BCAPIP=12E4                                         155.2, C
RSPCPP.KL=RCPP.K*CAPCAP.K                           156, R
DINVS.K=DINVS.J+DT*(RTCDS.JK-DPCFLS.JK)             157, L
DINVS=3E5                                           157.1, N
DINVP.K=DINVP.J+DT*(RTCDP.JK-DPCFLP.JK)             158, L
DINVP=3E5                                           158.1, N
RTCDS.KL=RRCWS.JK*ACDPWS.K                          159, R
RTCDP.KL=RRCWP.JK*ACDPWP.K                          160, R
    CAPIPS - ($) CAPITAL INVESTMNT ON PRODUCTION
               CAPACITY FROM WELLS DRILLED SOLELY
    RSPCPS - ($/M**2) RATE OF ADDITION OF INVESTMENT TO
               PRODUCTION CAPACITY OF WELLS DRILLED
               SOLELY
    DECFLS - ($/M) DEPRECIATION CASH FLOW FROM WELLS
               DRILLED SOLELY
    BCAPIS - ($) BASE VALUE OF CAPITAL INVESTMENT ON
               PRODUCTION CAPACITY FOR WELLS DRILLED
               SOLELY
    RCPS   - (B/M**2) RATE OF ADDITION OF PRODUCTION
               CAPACITY TO WELLS DRILLED SOLELY
    CAPCAP - ($/(B/M)) CAPITAL INVESTMENT ON PRODUCTION
               CAPACITY TO PRODUCE ONE BARREL OF OIL PER
               MONTH
    SCAP   - ($/(B/M)) SAMPLE VALUE OF CAPCAP
    CIF    - (1) COST INFLATION FACTOR
    ISCAP  - ($/B/M) COST OF ADDING PRODUCTION CAPACITY
               TO PRODUCE ONE BARREL OF OIL PER MONTH
    CAPIPP - ($) CAPITAL INVESTMENT ON PRODUCTION
               CAPACITY FROM WELLS DRILLED UNDER
               PARTNERSHIP
    RSPCPP - ($/M**2) RATE OF ADDITION OF INVESTMENT TO
               PRODUCTION CAPACITY OF WELLS DRILLED
               UNDER PARTNERSHIP
    DECFLP - $/M) DEPRECIATION CASH FLOW FROM WELLS
               DRILLED UNDER PARTNERSHIP
    BCAPIP - ($) BASE VALUE OF CAPITAL INVESTMENT ON
               PRODUCTION CAPACITY FOR WELLS DRILLED
               UNDER PARTNERSHIP
    RCPP   - (B/M**2) RATE OF ADDITION OF PRODUCTION
               CAPACITY TO WELLS DRILLED UNDER
               PARTNERSHIP
    DINVS  - ($) CAPITAL INVESTMENT ON DEVELOPING THE
               WELLS DRILLED SOLELY
    RTCDS  - ($/M) RATE OF ADDITION OF INVESTMENT ON
               DEVELOPMENT TO WELLS DRILLED SOLELY
    DPCFLS - ($/M) DEPLETION CASH FLOW PER MONTH FROM
               WELLS DRILLED SOLELY TO WELLS DRILLED
               SOLELY
    DINVP  - ($) CAPITAL INVESTMENT ON DEVELOPING THE
               WELLS DRILLED UNDER PARTNERSHIP
    RTCDP  - ($/M) RATE OF ADDITION OF INVESTMENT ON
               DEVELOPMENT TO WELLS DRILLED UNDER
               PARTNERSHIP
    DPCFLP - ($/M) DEPLETION CASH FLOW PER MONTH FROM
               WELLS DRILLED UNDER PARTNERSHIP
    RRCWS  - (W/M) RATE OF COMPLETION OF WELLS DRILLED
               SOLELY
    ACDPWS - ($/W) AVE COST OF DEVELOPMENT PER
               WELL(DRILLED SOLELY)
    RRCWP  - (W/M) RATE OF COMPLETION OF WELLS DRILLED
               UNDER PARTNERSHIP
    ACDPWP - ($/W) AVE COST OF DEVELOPMENT PER WELL(
               SHARING)
```

The capital investment in production capacity for wells drilled solely (CAPIPS, 151) is increased by the rate of addition of investment to production capacity of wells drilled solely (RSPCPS, 152) and reduced by the depreciation cash flow from wells drilled solely (DECFLS, 146). The rate of addition of investment to production capacity per month of wells drilled solely (RSPCPS, 152) is simply the product of the rate of addition of production capacity to wells drilled solely (RCPS, 88) and the capital investment needed to produce one barrel of oil per month (CAPCAP, 153).

It is assumed that the capital investment needed to produce one barrel of oil per month has an initial value of $20. The same logic applies to the capital investment in production capacity for wells drilled under partnership (CAPIPP, 155).

The book value of the capital investment in developing the wells drilled solely (DINVS, 157) is increased by the rate of addition of investment on development of wells drilled solely (RTCDS, 159) and reduced by the depletion cash flow from wells drilled solely (DPCFLS, 148). The rate of addition of investment on development to wells drilled solely (RTCDS, 159) is simply the product of the rate of completion of wells drilled solely (RRCWS, 59) and the average cost of development for wells drilled solely (ACDPWS, 111). The same logic applies to the book value of the capital investment on developing the wells drilled under partnership (DINVP, 158).

<u>Total assets</u>: The equations representing this are:

```
 TOTAL ASSETS

TASSET.K=TASSET.J+DT*(RAAST.JK-DDFL.JK)               161, L
TASSET=5E6                                            161.1, N
RAAST.KL=RSPCPS.JK+0.5*RSPCPP.JK+RTCDS.JK+0.5*        162, R
  RTCDP.JK
    TASSET - ($) TOTAL ASSETS
    RAAST  - ($/M) RATE OF ADDITION OF ASSETS
    DDFL   - ($/M) DEPRECIATION AND DEPLETION CASH FLOW
               PER MONTH
    RSPCPS - ($/M**2) RATE OF ADDITION OF INVESTMENT TO
               PRODUCTION CAPACITY OF WELLS DRILLED
               SOLELY
    RSPCPP - ($/M**2) RATE OF ADDITION OF INVESTMENT TO
               PRODUCTION CAPACITY OF WELLS DRILLED
               UNDER PARTNERSHIP
    RTCDS  - ($/M) RATE OF ADDITION OF INVESTMENT ON
               DEVELOPMENT TO WELLS DRILLED SOLELY
    RTCDP  - ($/M) RATE OF ADDITION OF INVESTMENT ON
               DEVELOPMENT TO WELLS DRILLED UNDER
               PARTNERSHIP
```

The total assets of the firm (TASSET, 161) are increased by the rate of addition of assets (RAAST, 162) and reduced by the depreciation and depletion cash flow (DDFL, 139).

EXPLORATION POLICY SECTOR

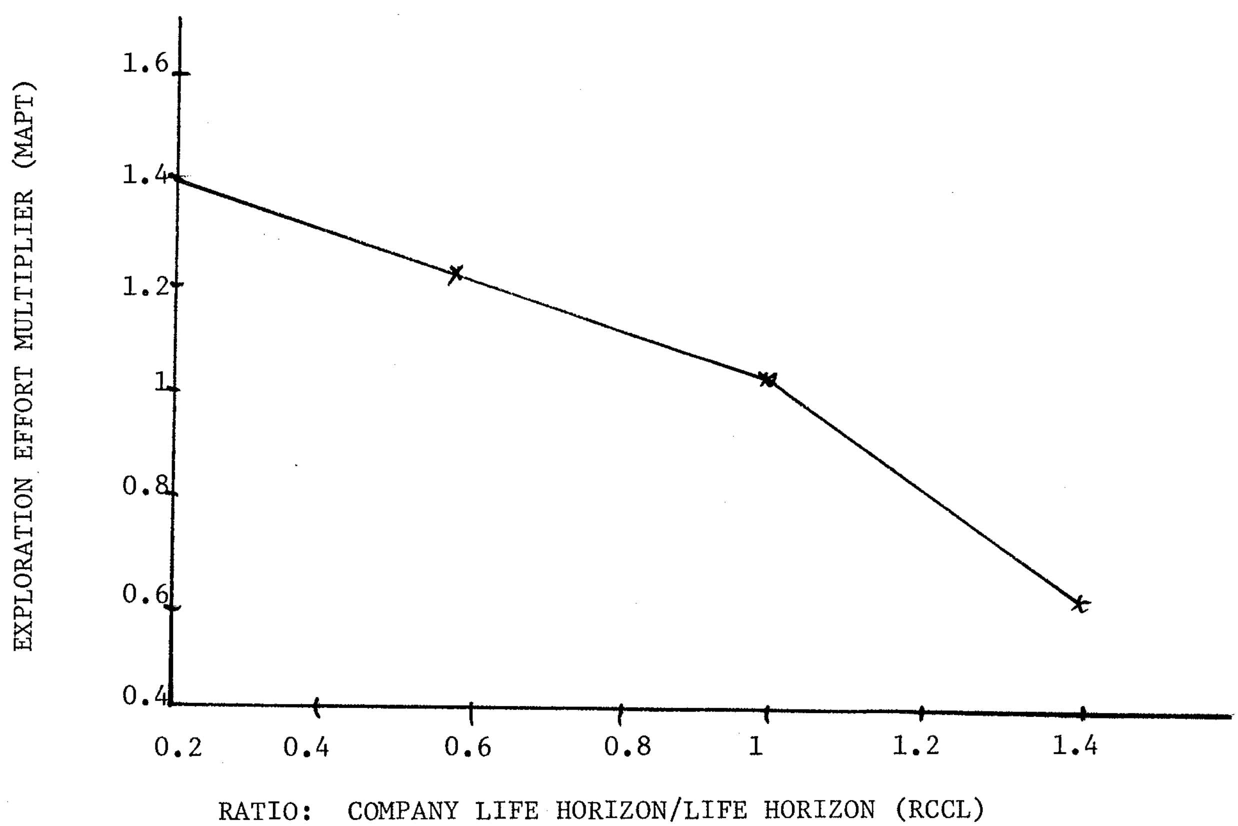
The equations representing this sector are:

```
  ** EXPLORATION POLICY SECTOR **

CAPTS.K=(MAX(CFLOW.K,O)*NVRES*MAPT.K)/12                    163, A
CAPTP.K=(MAX(CFLOW.K,O)*NVREP*MAPT.K*2)/12                  164, A
NVRES=0.3                                                   164.1, C
NVREP=0.4                                                   164.2, C
MAPT.K=TABHL(TAB6,RCCL.K,0.2,1.4,0.4)                       165, A
TAB6=1.4/1.2/1/0.6                                          165.1, T
RCCL.K=CLO.K/CLH                                            166, A
CLH=240                                                     166.1, C
CLO.K=TPRES.K/LAPR.K                                        167, A
LAPR.K=LAPRS.K+(0.5*LAPRP.K)                                168, A
    CAPTS  - ($/M) CAPITAL AVAILABLE FOR EXPLORATORY
               DRILLING(SOLELY)
    CFLOW  - ($/Y) CASH FLOW
    NVRES  - (1) NORMAL VALUE FOR FRACTION OF CASH FLOW
               RETAINED FOR EXPLORATION SPENDING(DRILL
               SOLELY)
    MAPT   - (1) MULTIPLIER TO INCREASE EXPLORATION WHEN
               COMPANY"S LIFE RATIO FALLS
    CAPTP  - ($/M) CAPITAL AVAILABLE FOR EXPLORATORY
               DRILLING(PARTNERSHIP)
    NVREP  - (1) NORMAL VALUE FOR FRACTION OF CASH FLOW
               RETAINED FOR EXPLORATION(DRILL UNDER
               PARTNERSHIP)
    TAB6   - (1) TABLE GIVING MULTIPLIER FOR EXPLORATION
               SPENDING
    RCCL   - (1) RATIO OF ACTUAL COMPANY'S LIFE TO
               COMPANY'S DESIRED LIFE HORIZO
    CLO    - (M) COMPANY ACTUAL LIFE HORIZON
    CLH    - (M) COMPANY DESIRED LIFE HORIZON
    TPRES  - (B) TOTAL PROVEN RESERVES
    LAPR   - (B/M) LONG TERM AVERAGE PRODUCTION RATE
    LAPRS  - (B/M) LONG TERM AVERAGE PRODUCTION RATE
               FROM WELLS COMPLETED SOLELY
    LAPRP  - (B/M) LONG TERM AVERAGE PRODUCTION RATE
               FROM WELLS COMPLETED UNDER PARTNERSHIP
```

The capital available for exploratory drilling (solely) (CAPTS, 163) is scaled up or down by a multiplier (MAPT, 165). The multiplier (MAPT, 165) reflects the company's policy to release funds for exploration and varies according to the values of the ratio of actual company's life (CLO, 167) to the company's desired life horizon (CLH) see Figure 4.5. The company's actual life time is the time by which it would go out of the business, given average production over the previous two years, if no further reserve were to be located. In this model it is assumed that the multiplier decreases as this ratio increases.

Figure 4.5 Relationship showing the ratio of the actual company life horizon to the company's desired life horizon and the exploration effort multiplier.



CHAPTER 5

THE FREE RUNNING MODEL

In this simulation run, the company is assumed to have conservative production and exploration policies as described in equations 91, 92, and equations 163, 164 and 165 respectively. The output of the selected performance parameters are shown in Fig. 5.1, Fig. 5.2, Fig. 5.3 and Fig. 5.4 and will be used as a benchmark for future experiments.

As seen from the figures, the cash flow, after-tax-profits, production rate from wells drilled solely and under partnership, total proven reserves and the number of exploratory wells (from those drilled solely and under partnership) increases very slowly throughout the life span. During the first five years (60 months) the return on investment fluctuates wildly and stabilizes at an average of 12 percent after that. The exploratory farmed out wells shows a cyclical behavior similar to that of the raw-land holdings (Fig. 5.4). This similarity in behavior can be explained by the fact that the model assumes that normally 5 percent of the acquisition land is farmed out but up to 10% of the raw-land holdings over a 5 year period may be farmed out if the actual holdings exceed the desired holdings. So if the raw-land holdings goes up, the farm-out acreage will also increase. Now the rate of exploratory farmed out wells is simply the ratio of the rate of acreage farmed out over the spacing per well which is a constant. This explains the similarity with the behavior on the raw-land holdings. In this model it is assumed that the company will purchase land at an "average price" that reflects their geological information mix of good, medium and poor information. This will be reflected not only in the price

FIGURE 5.1

FREE RUNNING MODEL

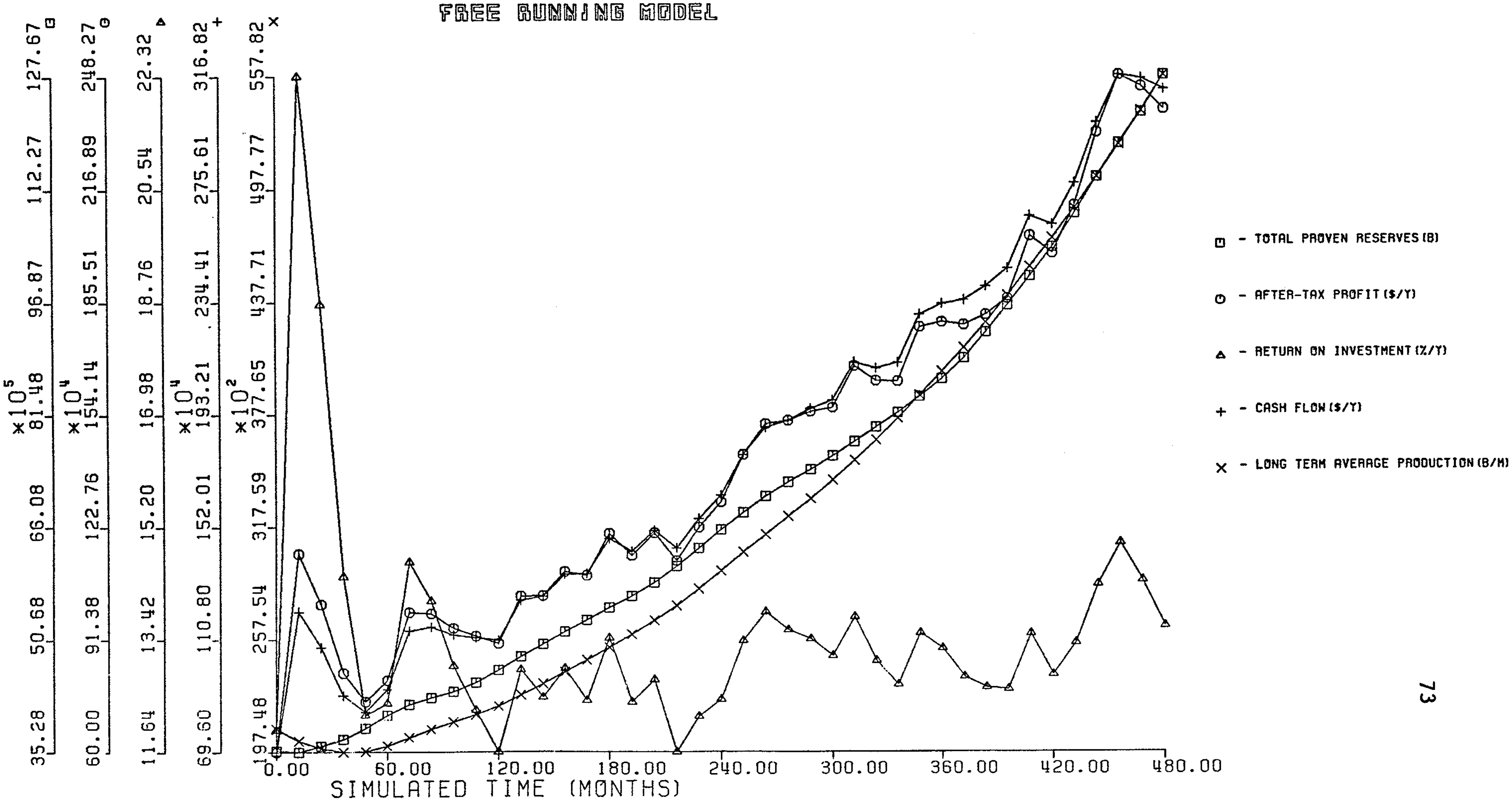


FIGURE 5.2

FREE RUNNING MODEL

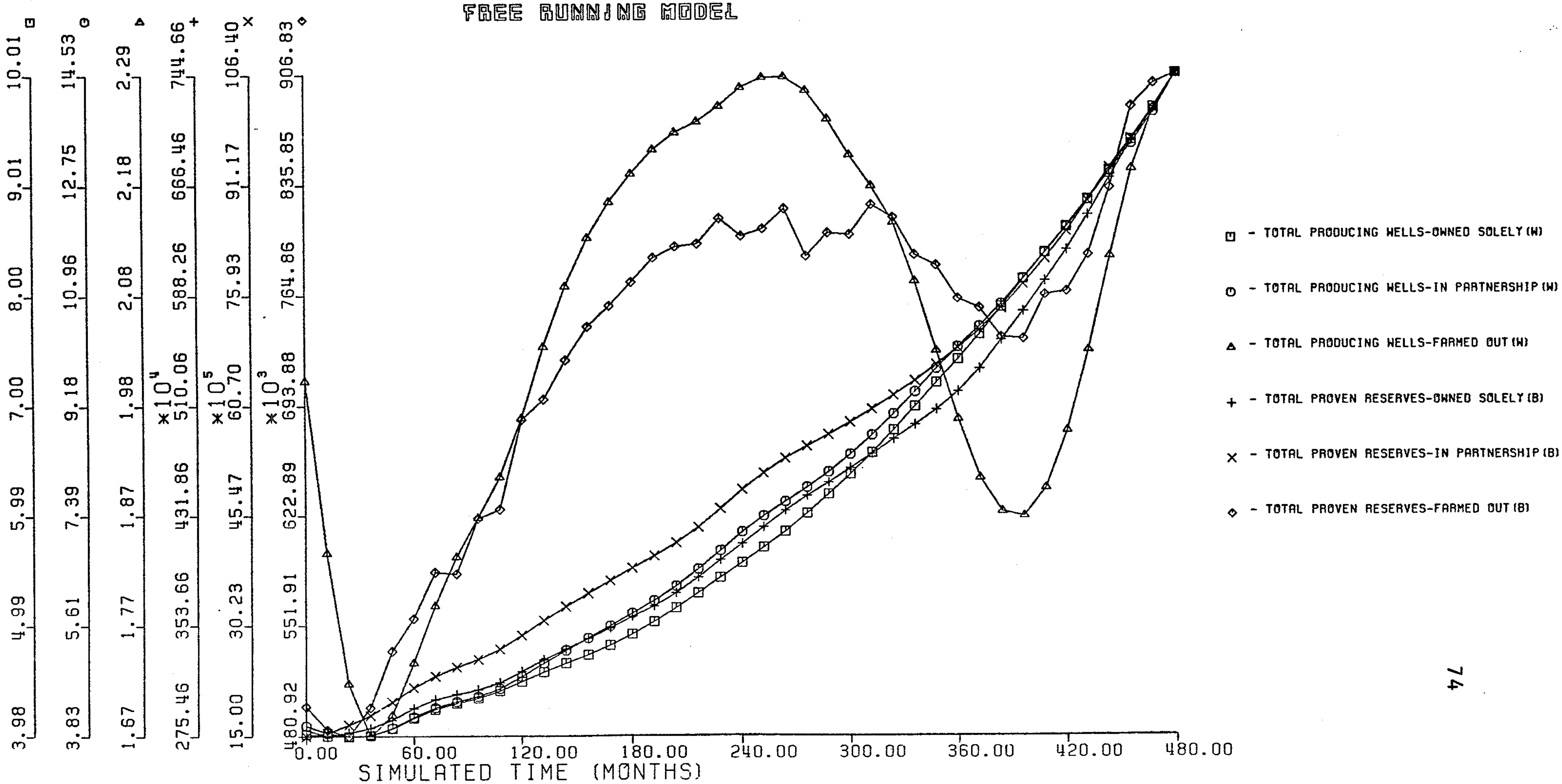


FIGURE 5.3

FREE RUNNING MODEL

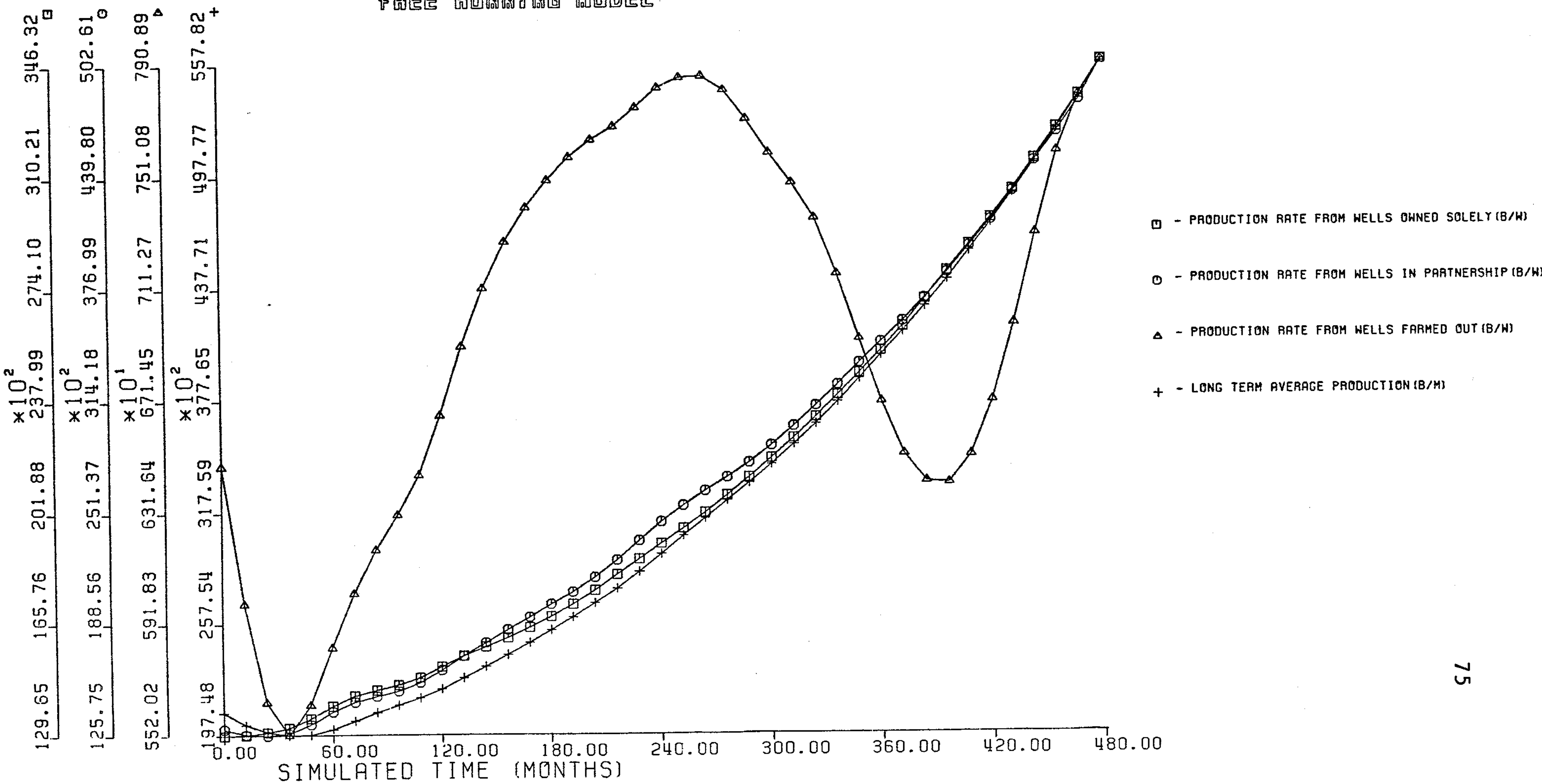
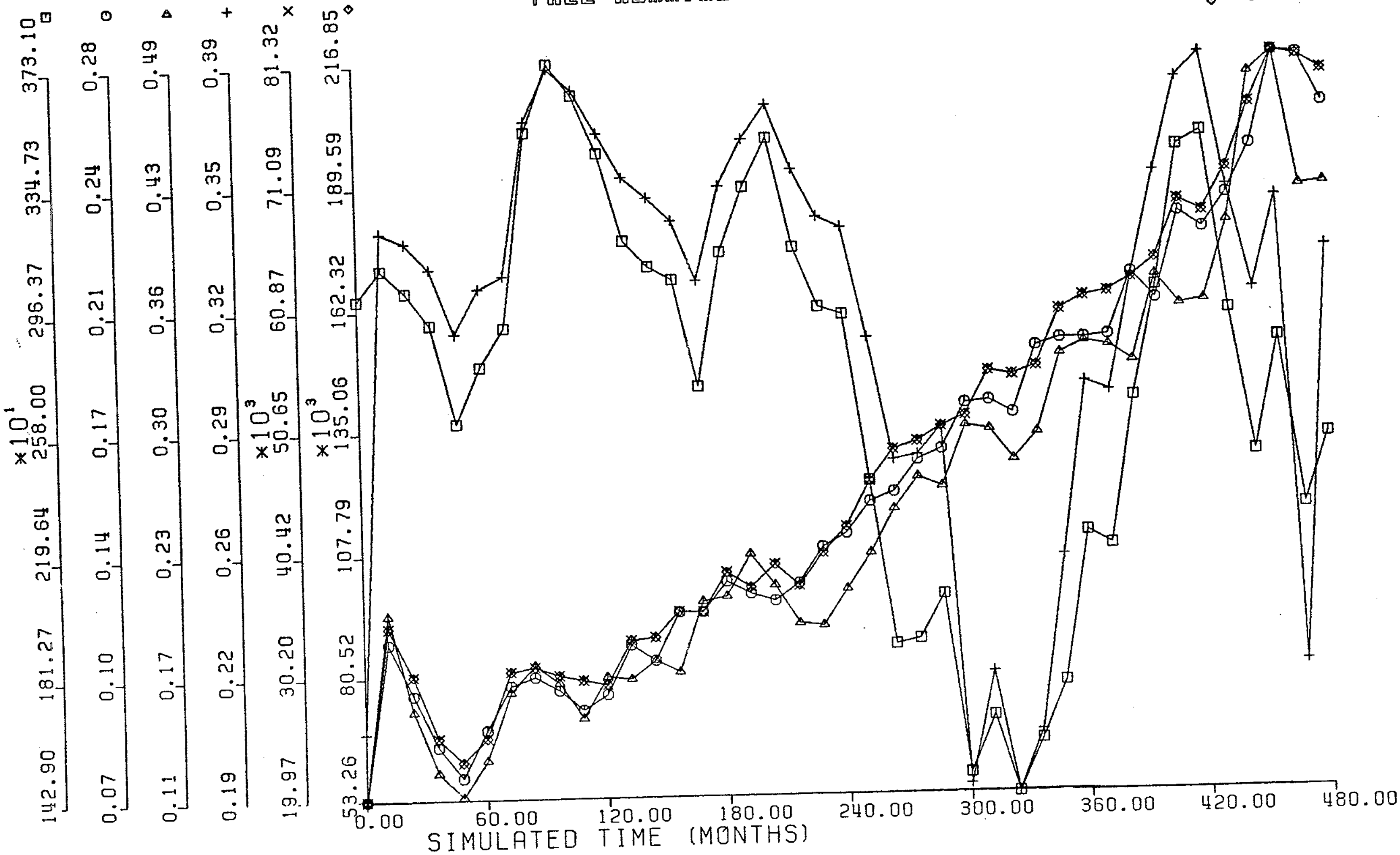


FIGURE 5.4

FREE RUNNING MODEL



but also in the mean of the distribution of success in exploring.

Furthermore the coefficient of quality of geological information and the mean of distribution of success in exploring are both assumed to follow a normal distribution which results in the cyclical behavior of the raw-land holdings. By the same logic, the rate of addition of the successful exploratory farmed out wells is simply assumed to follow a normal distribution with mean 8 percent and standard deviation 1 percent of the exploratory farmed out wells. The total number of successful producing farmed out wells is a direct outcome of the successful exploratory farmed out wells. The total proven reserves is also obtained from the successful exploratory farmed out wells, but naturally they would be expected to exhibit the same cyclical behaviors as shown in the figures.

An explanation of the behavior of the other plotted variables follows. Initially the amount of funds released by the company, be it for drilling solely or under partnership, is not high enough to increase significantly the successful number of exploratory wells. This in turn results only in a marginal number of new producing wells being added per year. Combining this with the wearing out of the current producing wells, the net effect is such that the production rate also remains quite stagnant over the years. The income generated from the low production is not high enough for the company to embark on more extensive exploratory drilling even if it so desires (note that this model assumes that all the money used for exploration are generated internally without any external borrowings). As such there is no significant addition to the total proven reserves. The low proven reserves affects the company's production policy by reducing its production rate in order to conserve the reserves and to maintain its life horizon (note that the company's actual life horizon = total proven reserves/long term average production rate). The cut in production rate per well helps to stabilize the reserves which in turn increases the actual life horizon of the company. In response to a longer life horizon, the company releases less funds for exploration which shows down the exploration rate. Thus the cycle repeats.

It is now quite clear that by adopting these conservative policies, the company seems to remain stagnant and in times of major external shocks like a huge drop in oil prices, very low success rate, low reserves etc., the company might not be able to survive. It is thus interesting to find out what exploration and production policies the company could pursue, how the changes in the oil prices, reduction in the allowable rate of production, etc., can affect the performance of the company. This is the subject of Chapter 6.

CHAPTER 6

EXPERIMENTS WITH THE MODEL

In order to probe deeper into the behavior of the model to see how various external shocks can affect the behavior of the model and to see how the various exploration and production policies can be adopted to improve the performance of the model, a few experimental runs were conducted with the comparative plots of the various runs shown in Fig. 6.1 - Fig. 6.12.

First, we will describe how the values of the different parameters during the various runs are changed followed by the analysis of the results.

Run 1:

The allowable rate of production per well is reduced from 3500 barrels per month per well from year 10 onward to 3000 barrels per month per well i.e. CIALP=-500. This represents an authorized (by a Government Agency or Commission) cut in production to conserve the natural resource.

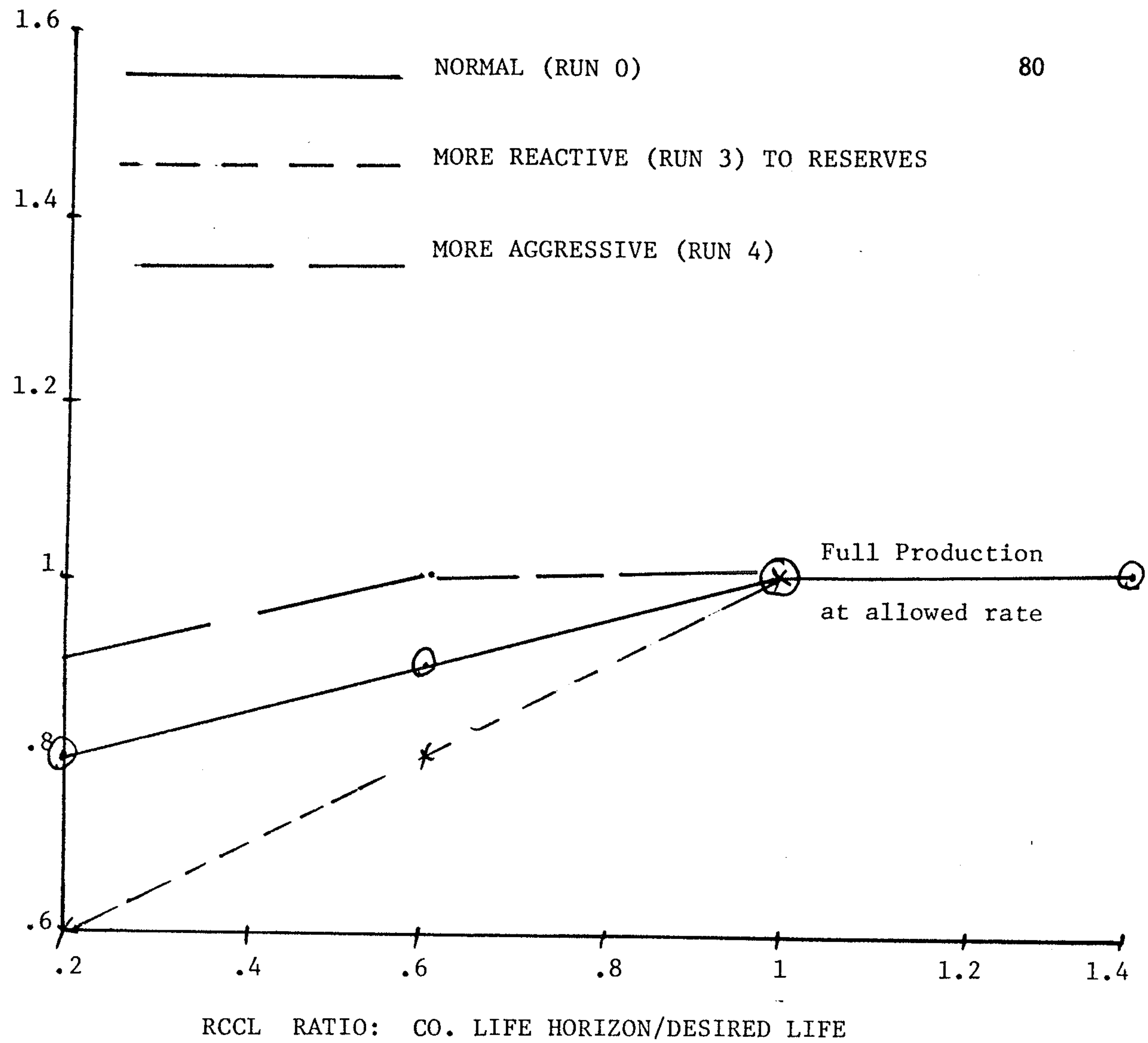
Run 2:

The success rate of the wildcat exploratory drilling (drilled solely and under partnership) are reduced from 15 percent to 10 percent i.e. WSRS= 0.1, WSRP=0.1.

Run 3:

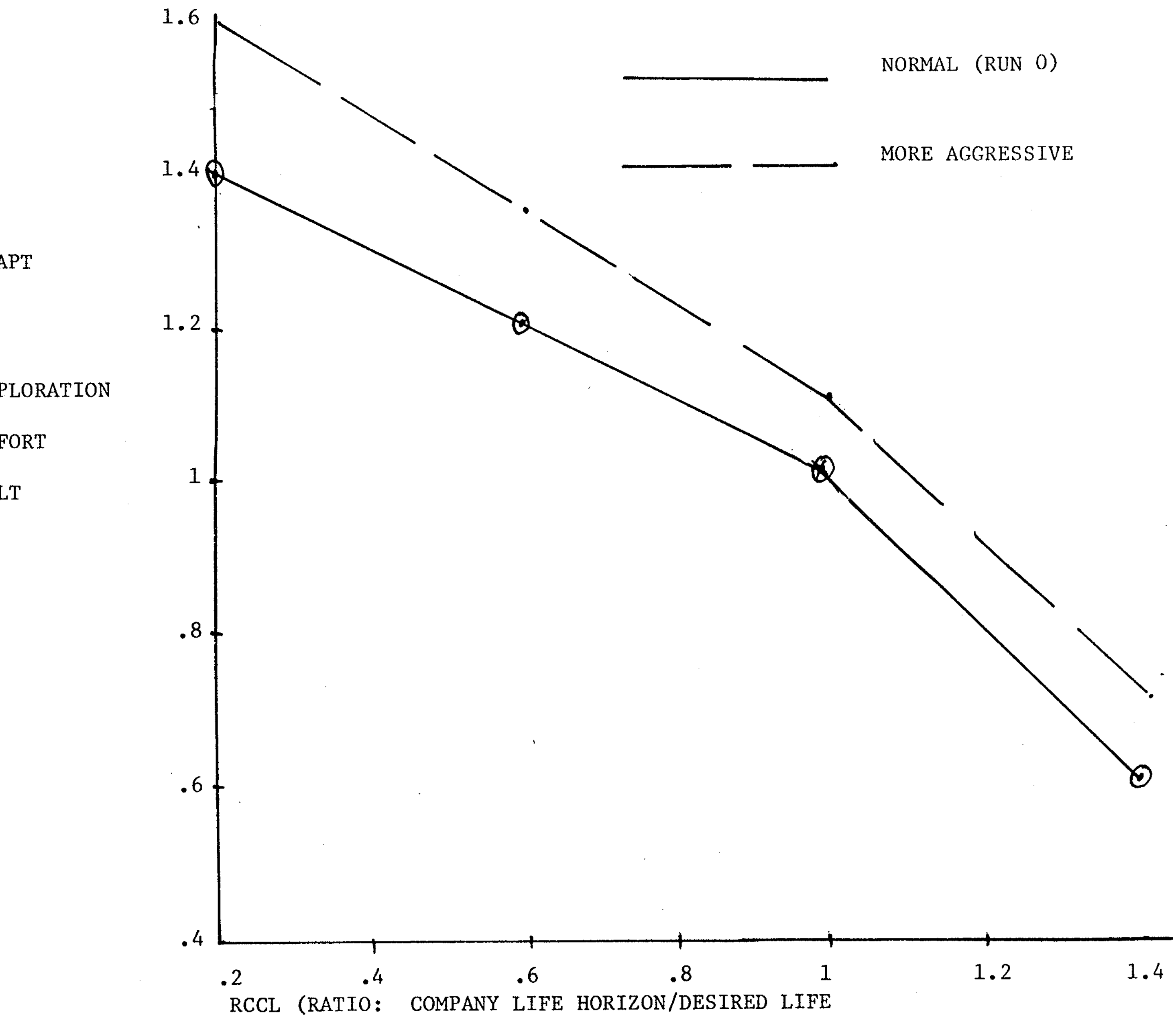
In this run the company adopts a production policy which is more reactive to reserves compared to the free running model. It adjusts its production rate by a bigger margin than the normal run in response to the company's actual life horizon i.e. T TPRTW = 0.6/0.8/1/1 (see TABLE 6.1).

TABLE 6.1 Production Policy with respect to Oil Reserves



Production Policy with respect to Reserves	PERCEIVED STATE OF OIL RESERVES (RCCL)			
	Very Low	Low	Satisfactory	High
	.2	.6	1	1.4
NORMAL	.8	.9	1	1
MORE REACTIVE	.6	.8	1	1
MORE AGGRESSIVE STANCE	.9	1	1	1

TABLE 6.2 Exploration Policy with respect to Oil Reserves



	Exploration Policy with respect to Reserves	PERCEIVED STATE OF OIL RESERVES Very Low .2	Low .6	Satisfactory 1	High 1.4
MAPT (Tab. 6)	Normal	1.4	1.2	1.1	0.6
	More Aggressive Stance	1.6	1.24	1.1	0.7

Run 4:

In this run the company adopts a much more aggressive stance by adopting the following policies:

(1) Produce at a rate near the maximum allowable production rate i.e. T TPRTW = 0.9/1/1/1 (see TABLE 6.1) and,

(2) Increases more drastically the funds for exploration in response to a decline in the company's actual life horizon i.e. TAB6 = 1.6/1.24/1.1/ 0.7 (see TABLE 6.2).

Run 5:

In this run the oil price increases by 15 percent from year 10 onwards to $20.70 per barrel.

Run 6:

In this run the oil price decreases by 15 percent from year 10 onwards to $15.30 per barrel.

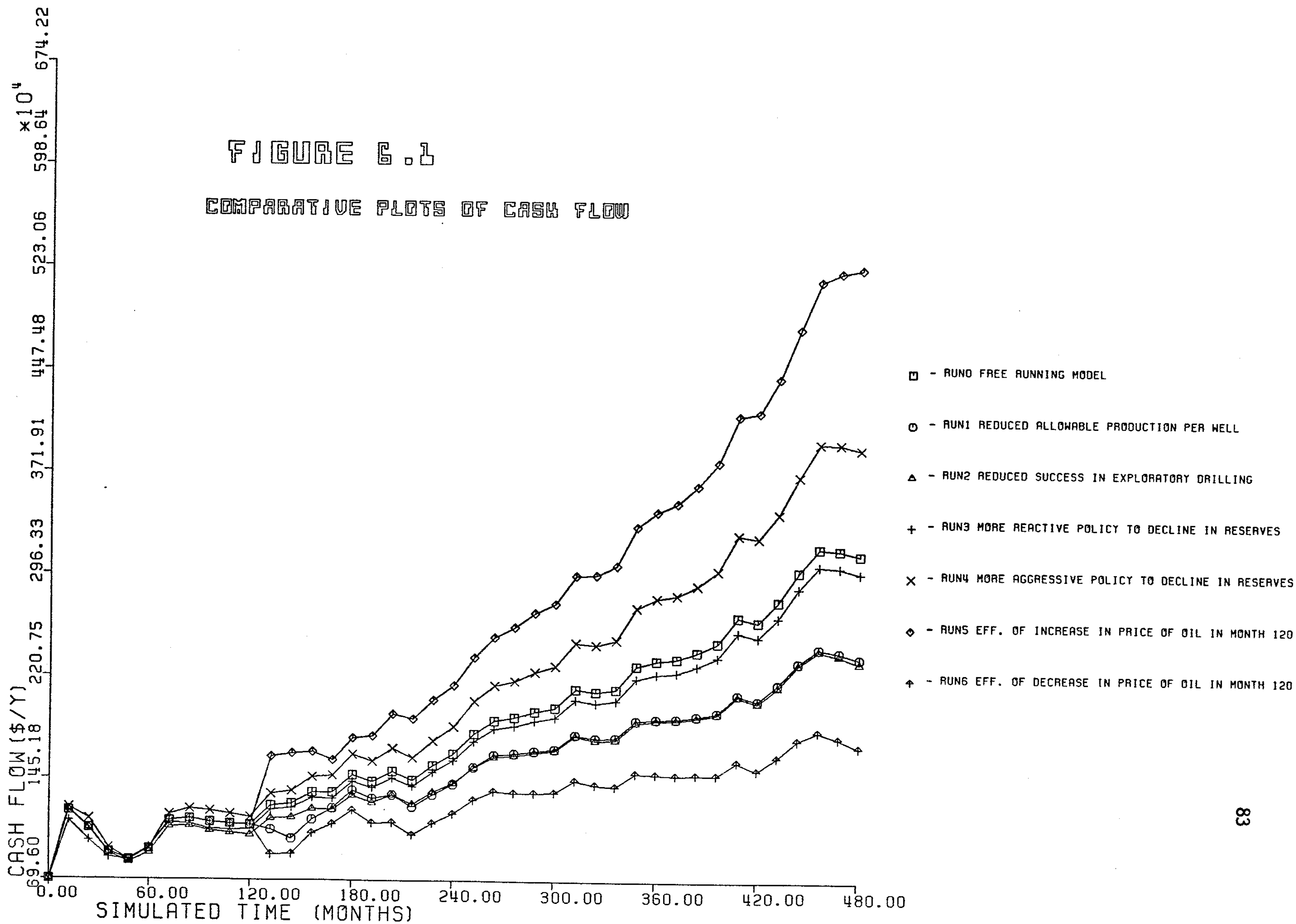


FIGURE 6.1

COMPARATIVE PLOTS OF CASH FLOW

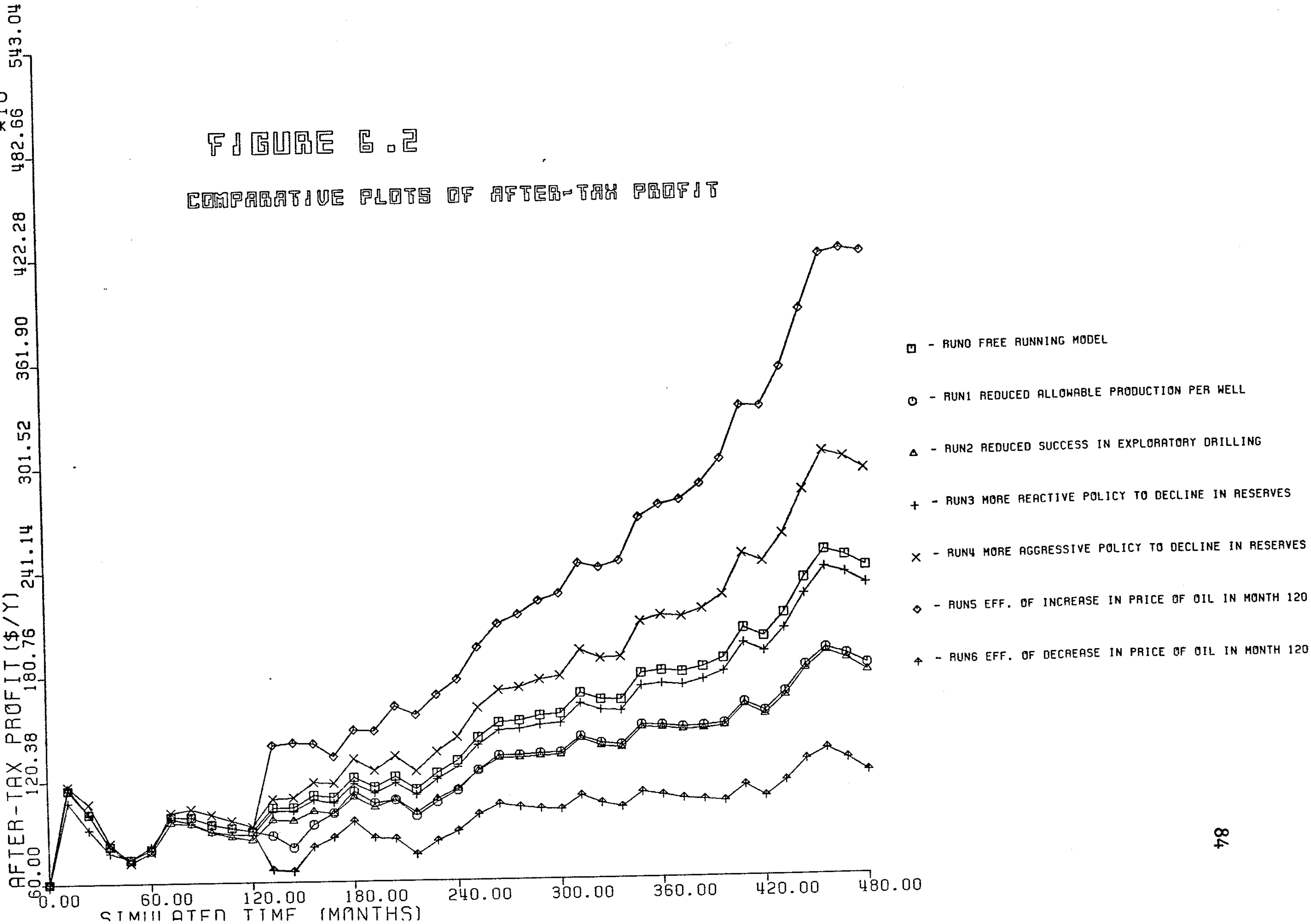


FIGURE 6.2

COMPARATIVE PLOTS OF AFTER-TAX PROFIT

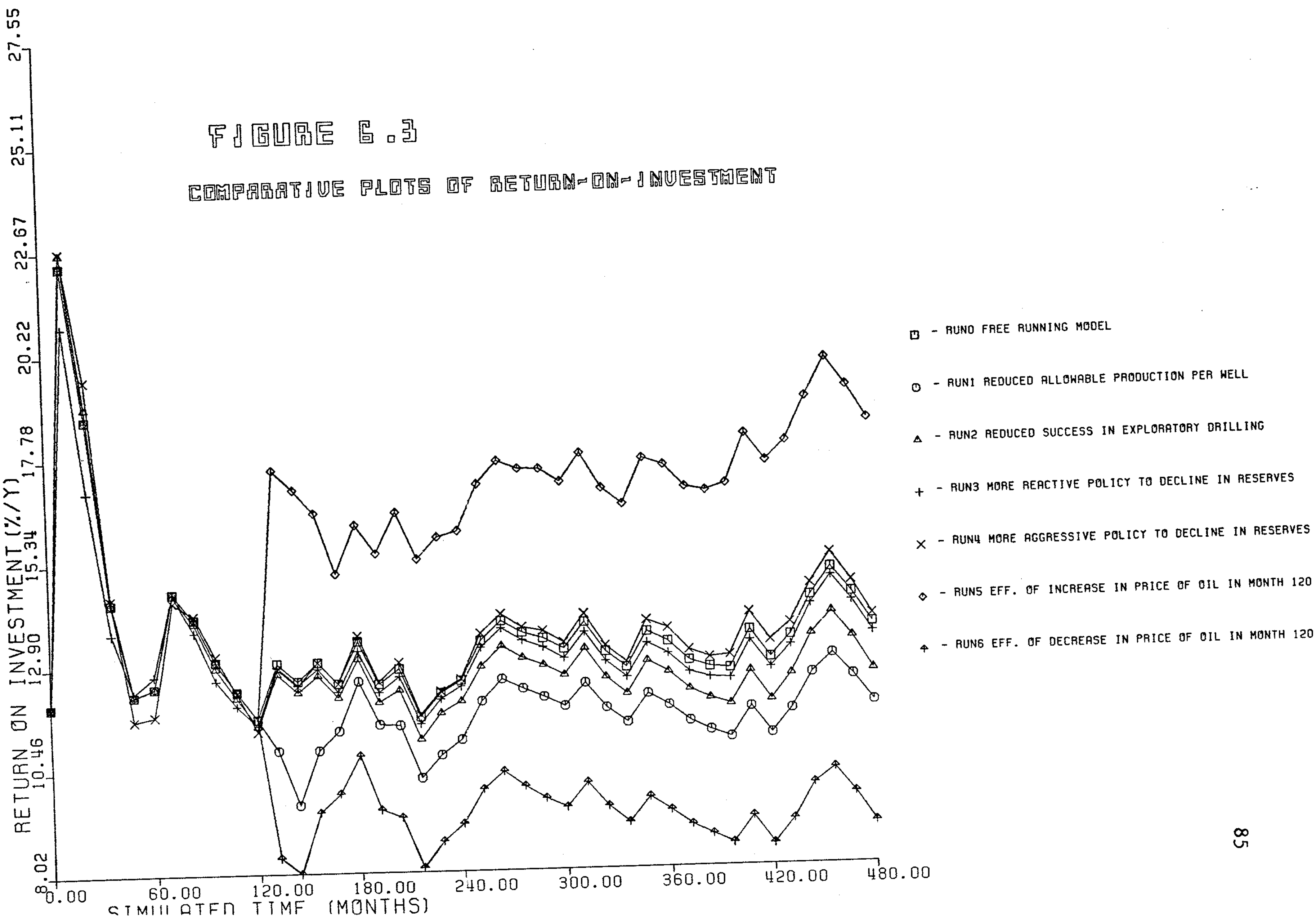


FIGURE 6.3

COMPARATIVE PLOTS OF RETURN-ON-INVESTMENT

FIGURE 6.4

COMPARATIVE PLOTS OF TOTAL PROVEN RESERVES

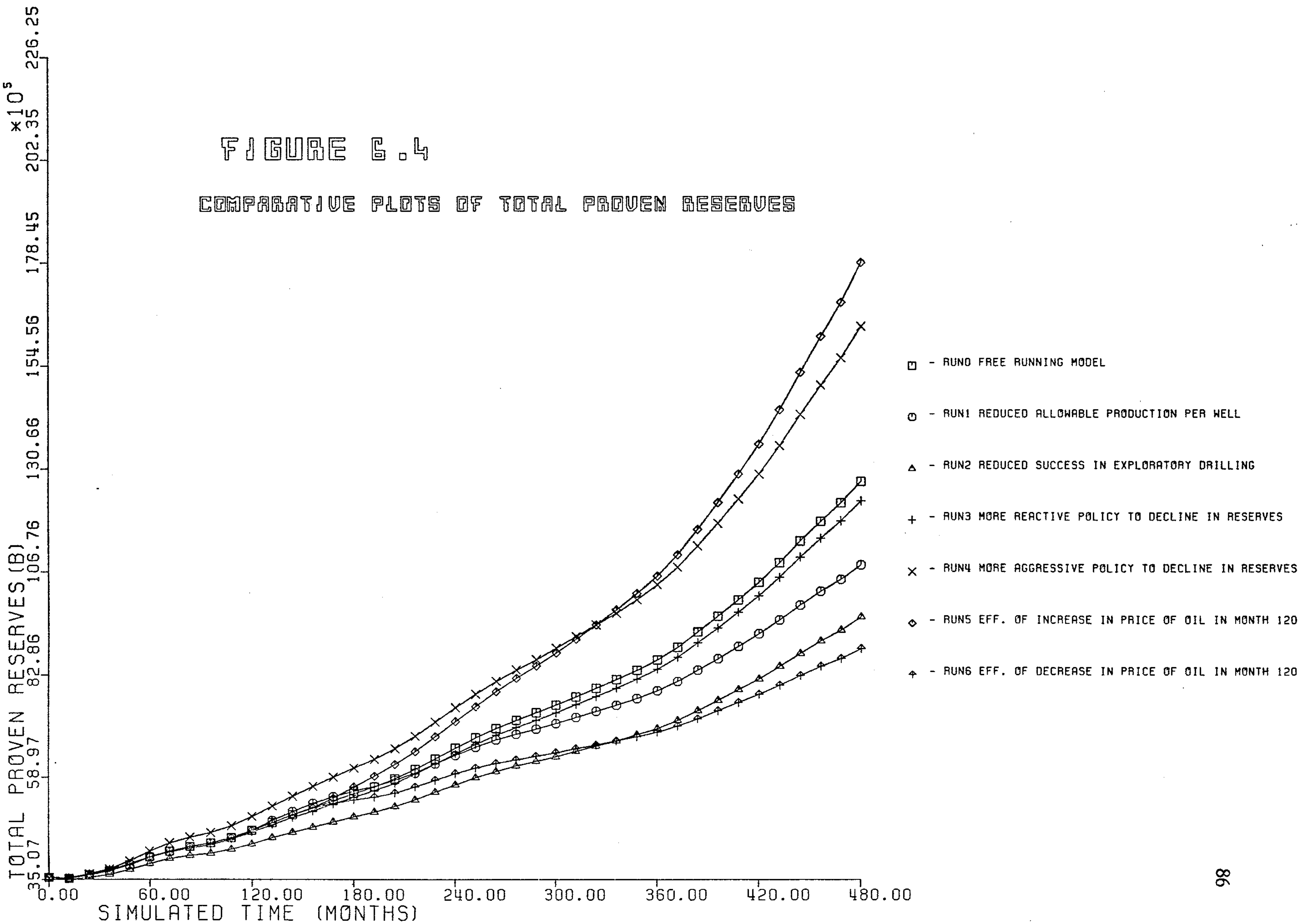
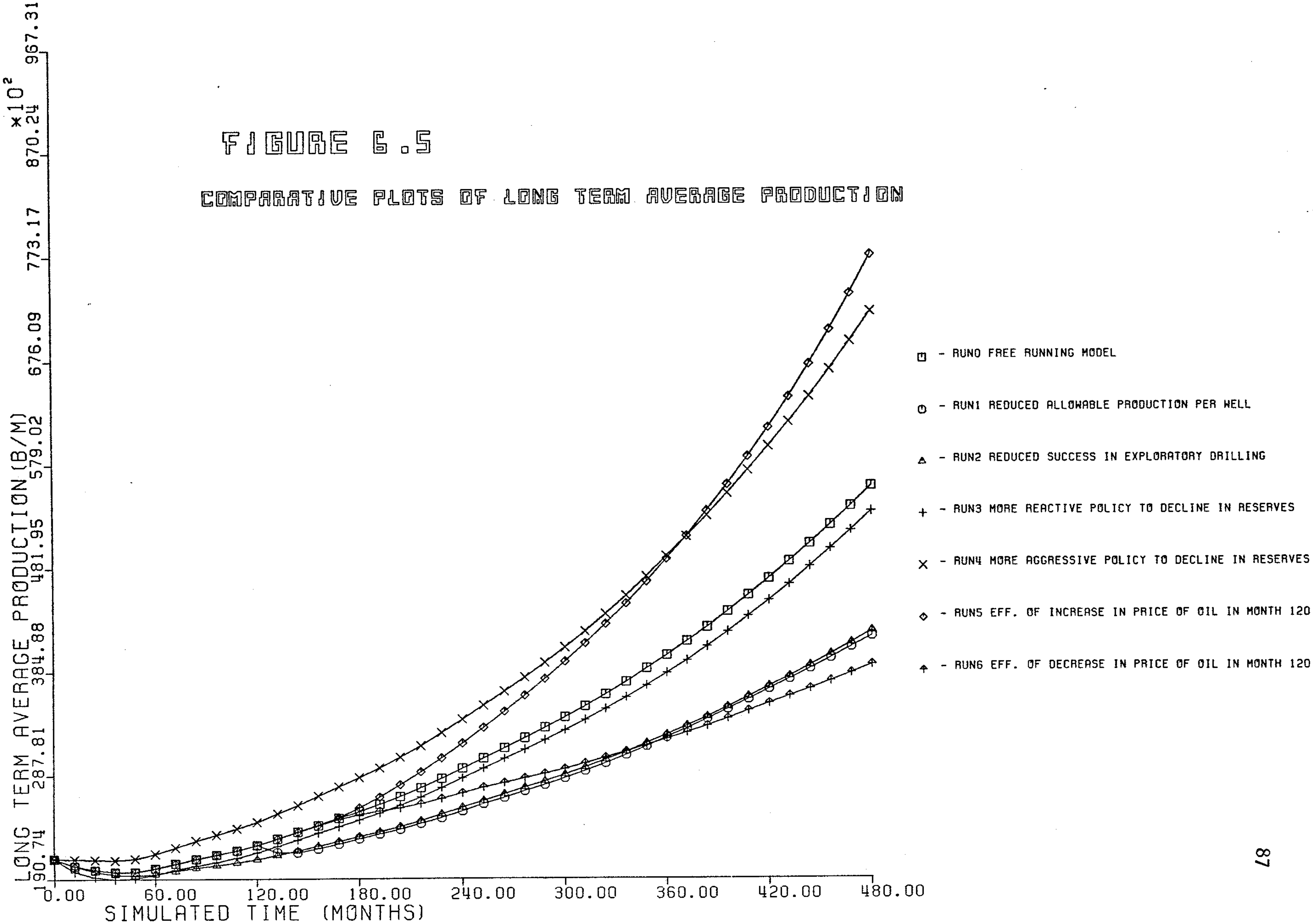


FIGURE 6.5

COMPARATIVE PLOTS OF LONG TERM AVERAGE PRODUCTION



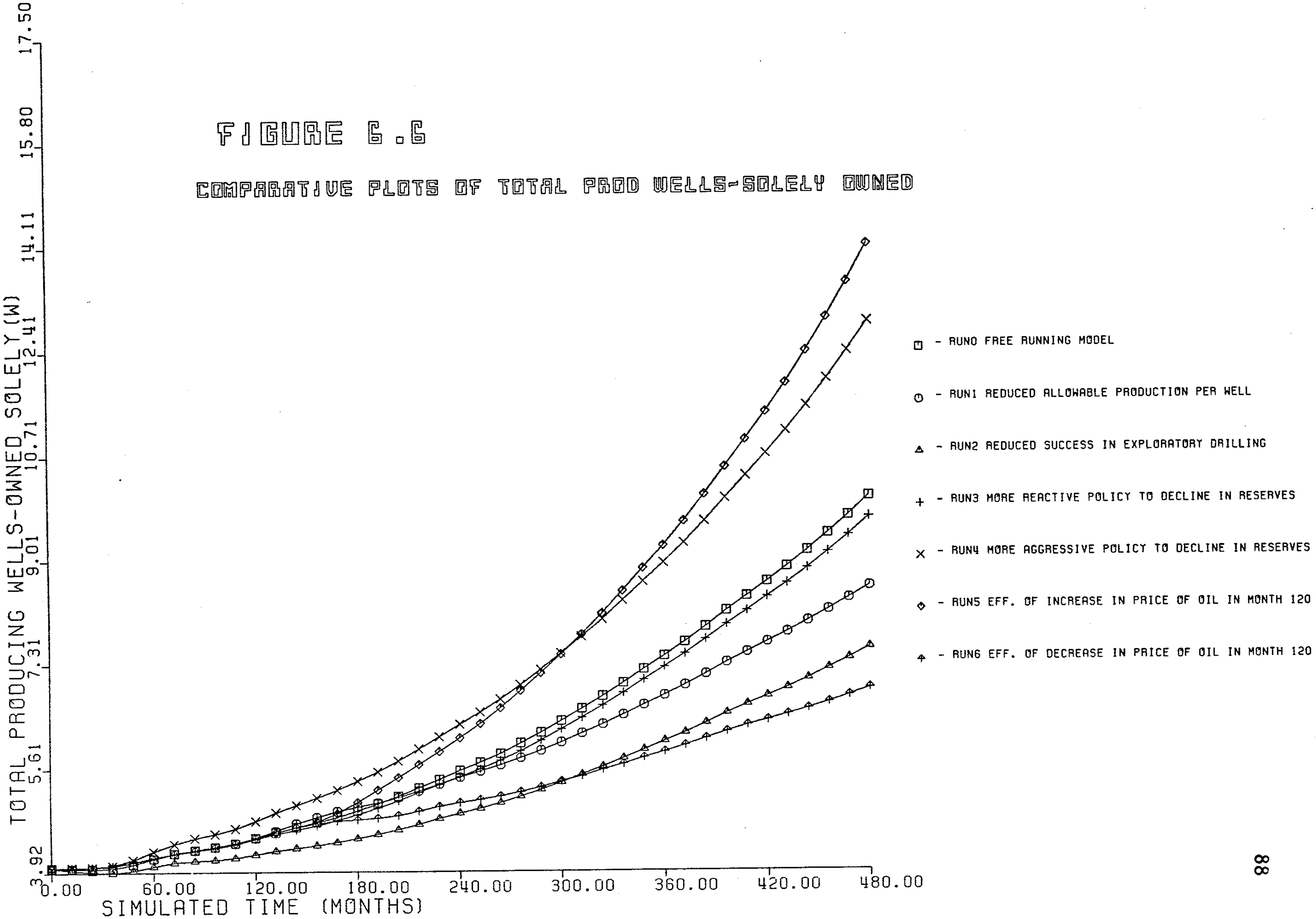


FIGURE 6.6

COMPARATIVE PLOTS OF TOTAL PROD WELLS-SOLELY OWNED

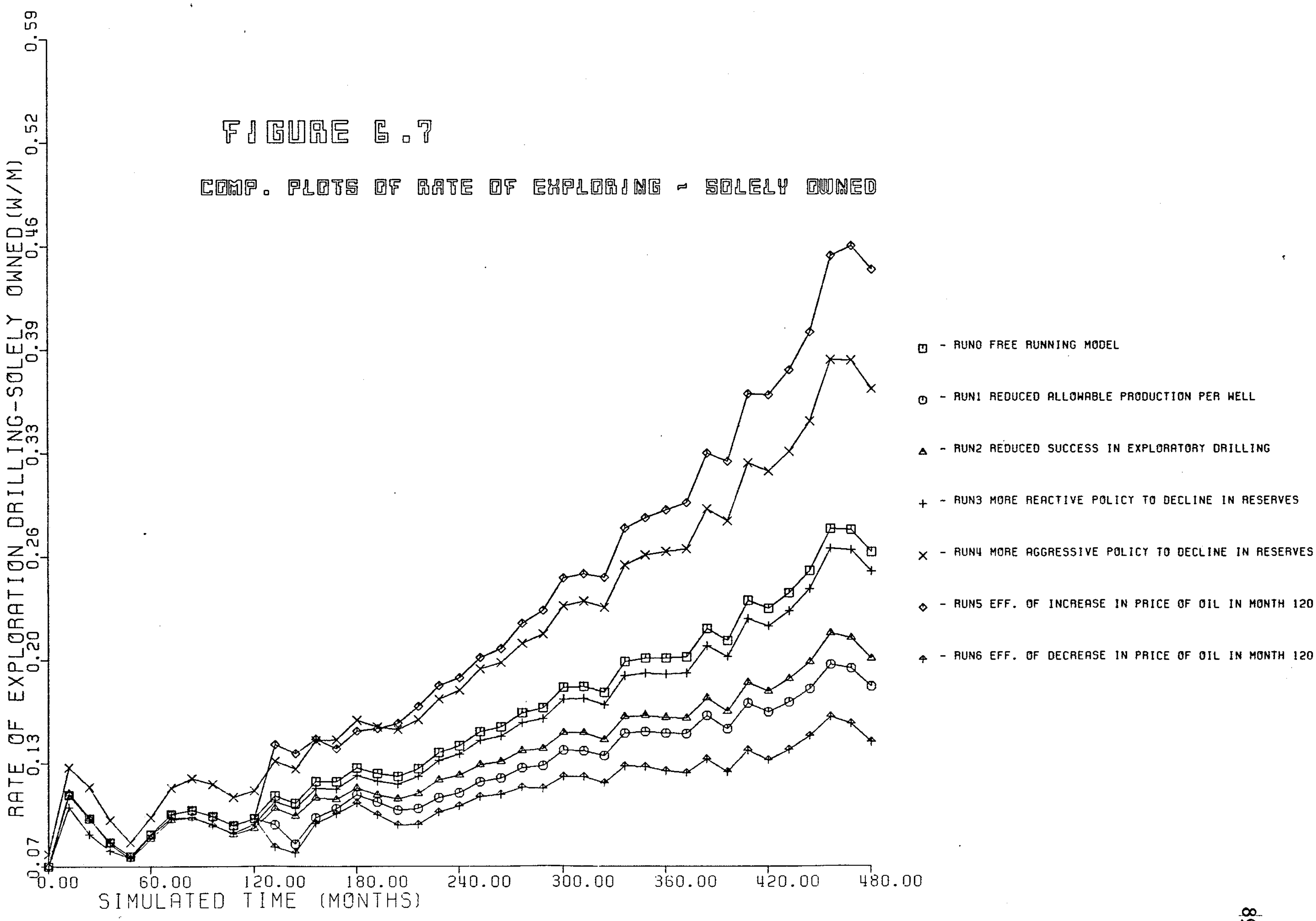


FIGURE 6.7
COMP. PLOTS OF RATE OF EXPLORING - SOLELY OWNED
RATE OF EXPLORATION DRILLING-SOLELY OWNED (W/M)
0.07
0.13
0.20
0.26
0.33
0.39
0.46
0.52
0.59
0.00
60.00
120.00
180.00
240.00
300.00
360.00
420.00
480.00
SIMULATED TIME (MONTHS)
- RUN0 FREE RUNNING MODEL
- RUN1 REDUCED ALLOWABLE PRODUCTION PER WELL
- RUN2 REDUCED SUCCESS IN EXPLORATORY DRILLING
- RUN3 MORE REACTIVE POLICY TO DECLINE IN RESERVES
- RUN4 MORE AGGRESSIVE POLICY TO DECLINE IN RESERVES
- RUN5 EFF. OF INCREASE IN PRICE OF OIL IN MONTH 120
- RUN6 EFF. OF DECREASE IN PRICE OF OIL IN MONTH 120

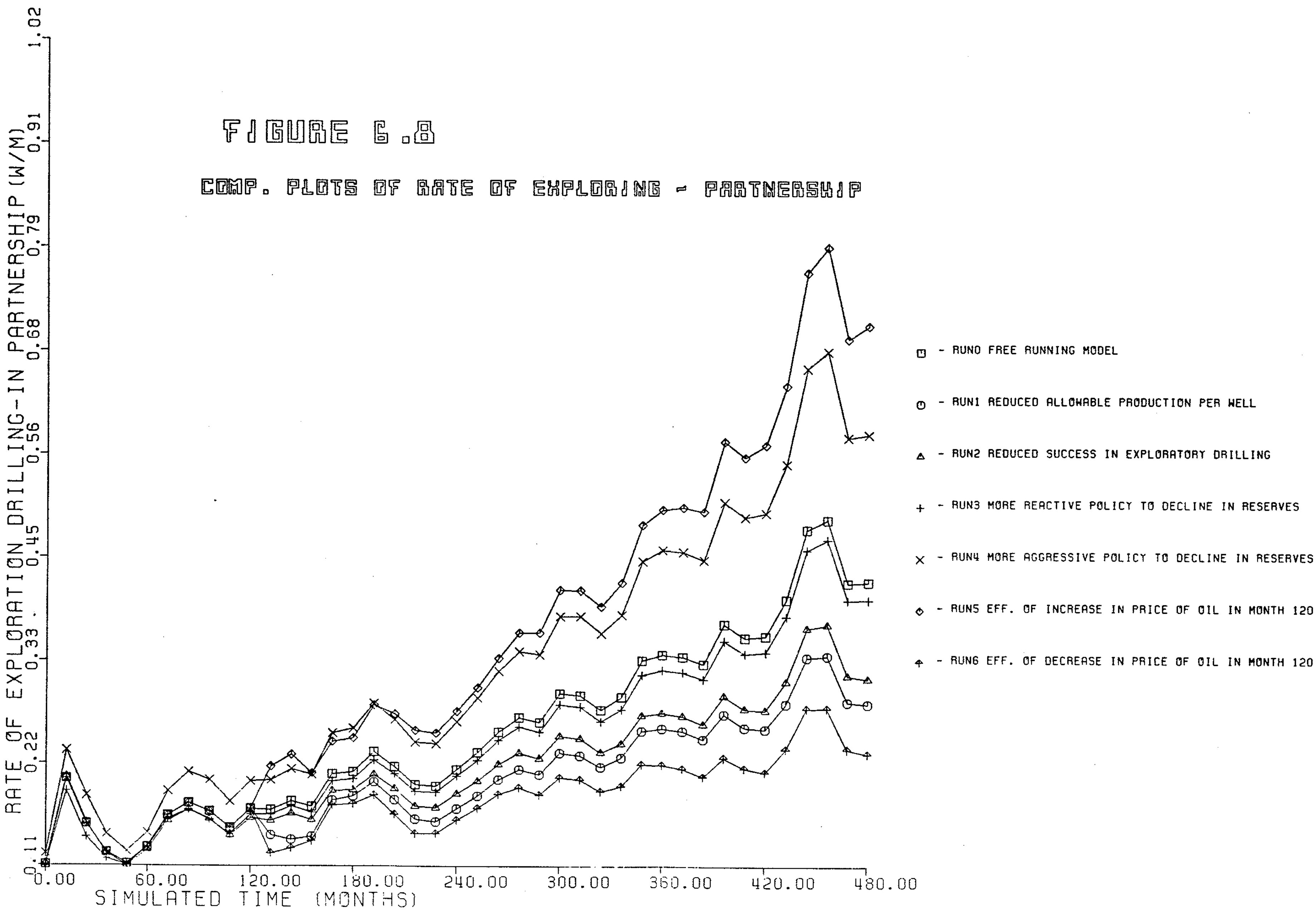


FIGURE 6.8
COMP. PLOTS OF RATE OF EXPLORING - PARTNERSHIP
RATE OF EXPLORATION DRILLING-IN PARTNERSHIP (W/M)
0.11
0.22
0.33
0.45
0.56
0.68
0.79
0.91
1.02
0.00
60.00
120.00
180.00
240.00
300.00
360.00
420.00
480.00
SIMULATED TIME (MONTHS)
- RUN0 FREE RUNNING MODEL
- RUN1 REDUCED ALLOWABLE PRODUCTION PER WELL
- RUN2 REDUCED SUCCESS IN EXPLORATORY DRILLING
- RUN3 MORE REACTIVE POLICY TO DECLINE IN RESERVES
- RUN4 MORE AGGRESSIVE POLICY TO DECLINE IN RESERVES
- RUN5 EFF. OF INCREASE IN PRICE OF OIL IN MONTH 120
- RUN6 EFF. OF DECREASE IN PRICE OF OIL IN MONTH 120

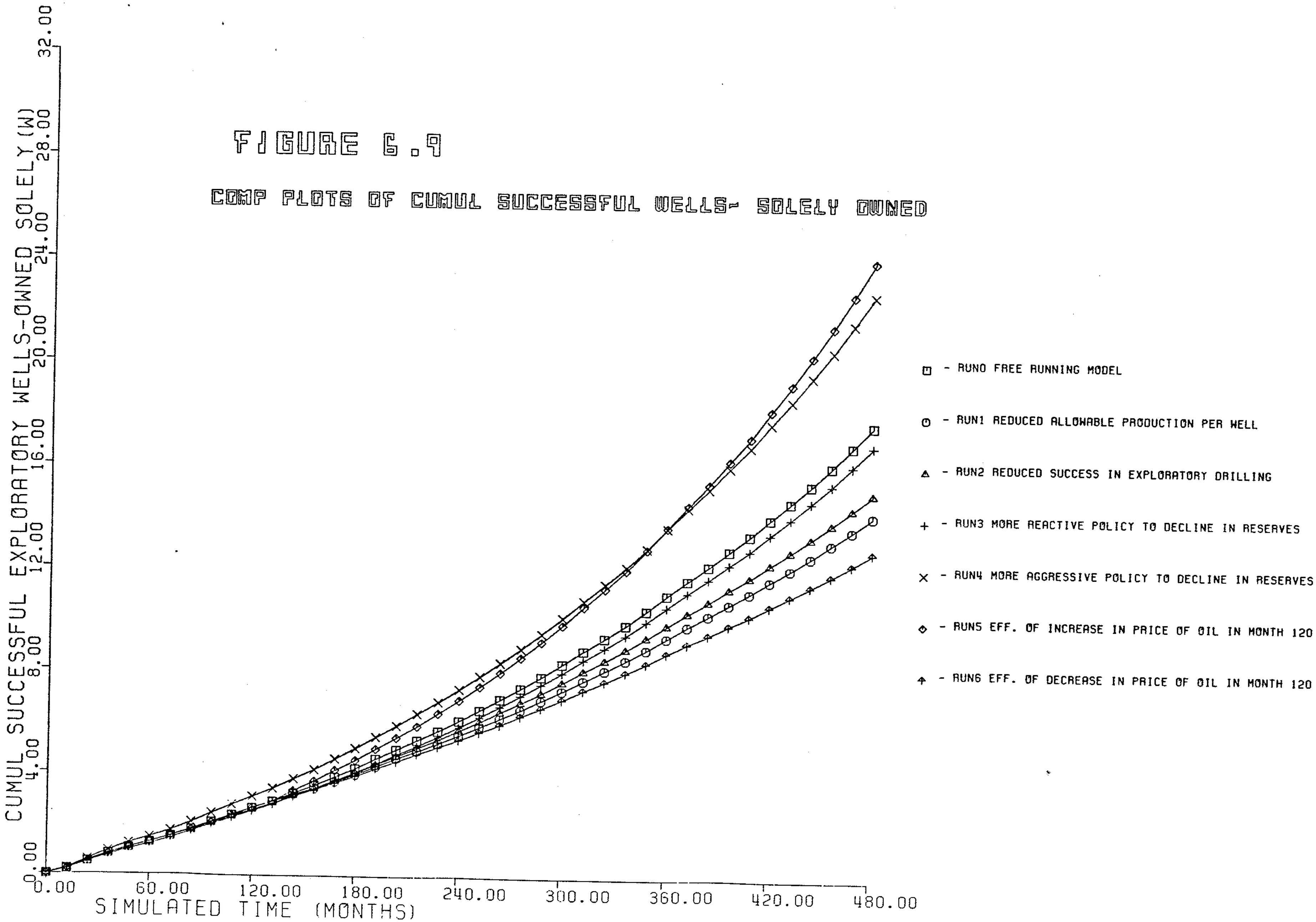
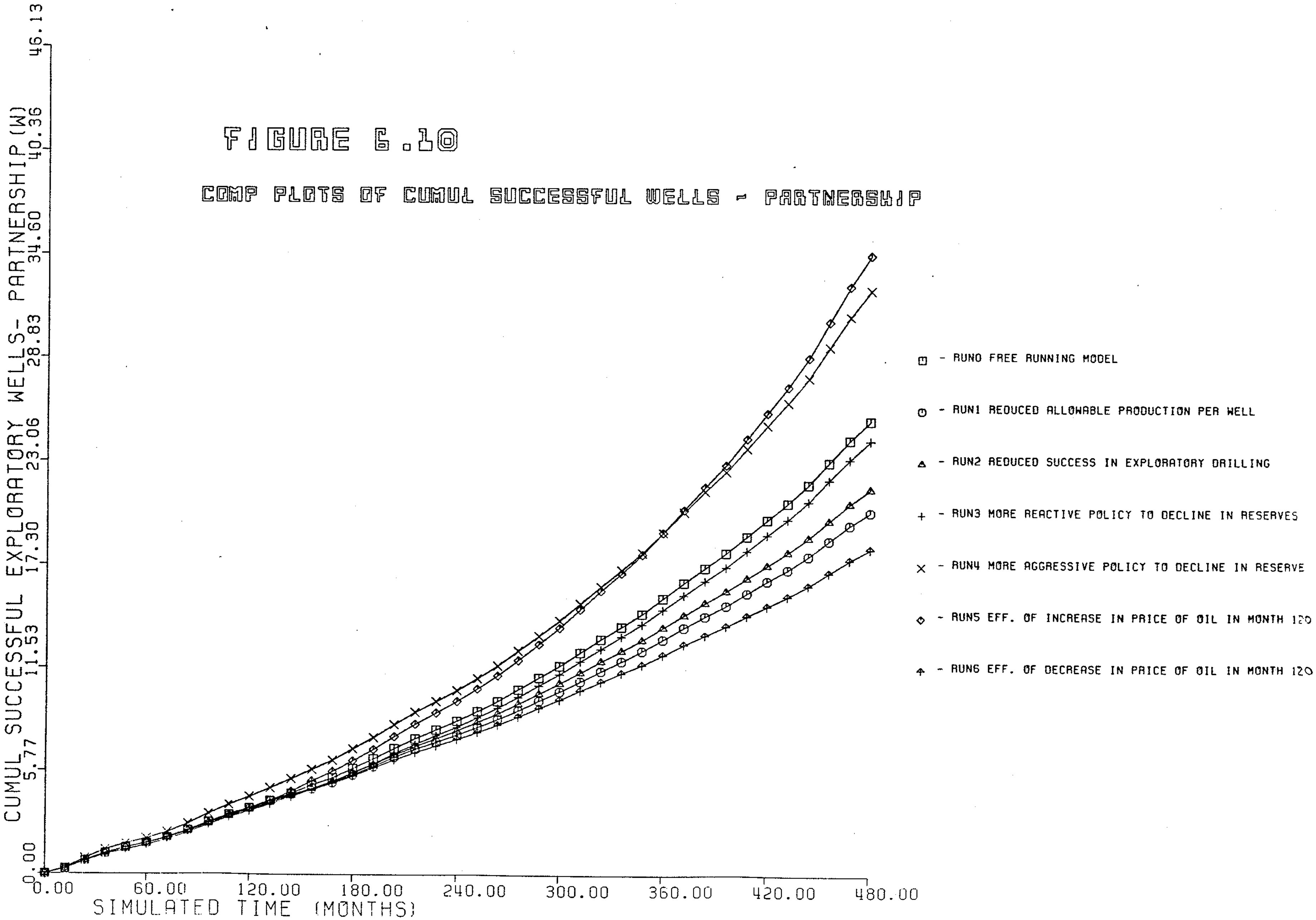


FIGURE 6.9
COMP PLOTS OF CUMUL SUCCESSFUL WELLS- SOLELY OWNED
CUMUL SUCCESSFUL EXPLORATORY WELLS-OWNED SOLELY (W)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
0.00
60.00
120.00
180.00
240.00
300.00
360.00
420.00
480.00
SIMULATED TIME (MONTHS)
- RUN0 FREE RUNNING MODEL
- RUN1 REDUCED ALLOWABLE PRODUCTION PER WELL
- RUN2 REDUCED SUCCESS IN EXPLORATORY DRILLING
- RUN3 MORE REACTIVE POLICY TO DECLINE IN RESERVES
- RUN4 MORE AGGRESSIVE POLICY TO DECLINE IN RESERVES
- RUN5 EFF. OF INCREASE IN PRICE OF OIL IN MONTH 120
- RUN6 EFF. OF DECREASE IN PRICE OF OIL IN MONTH 120

FIGURE 6.10

COMP PLOTS OF CUMUL SUCCESSFUL WELLS - PARTNERSHIP



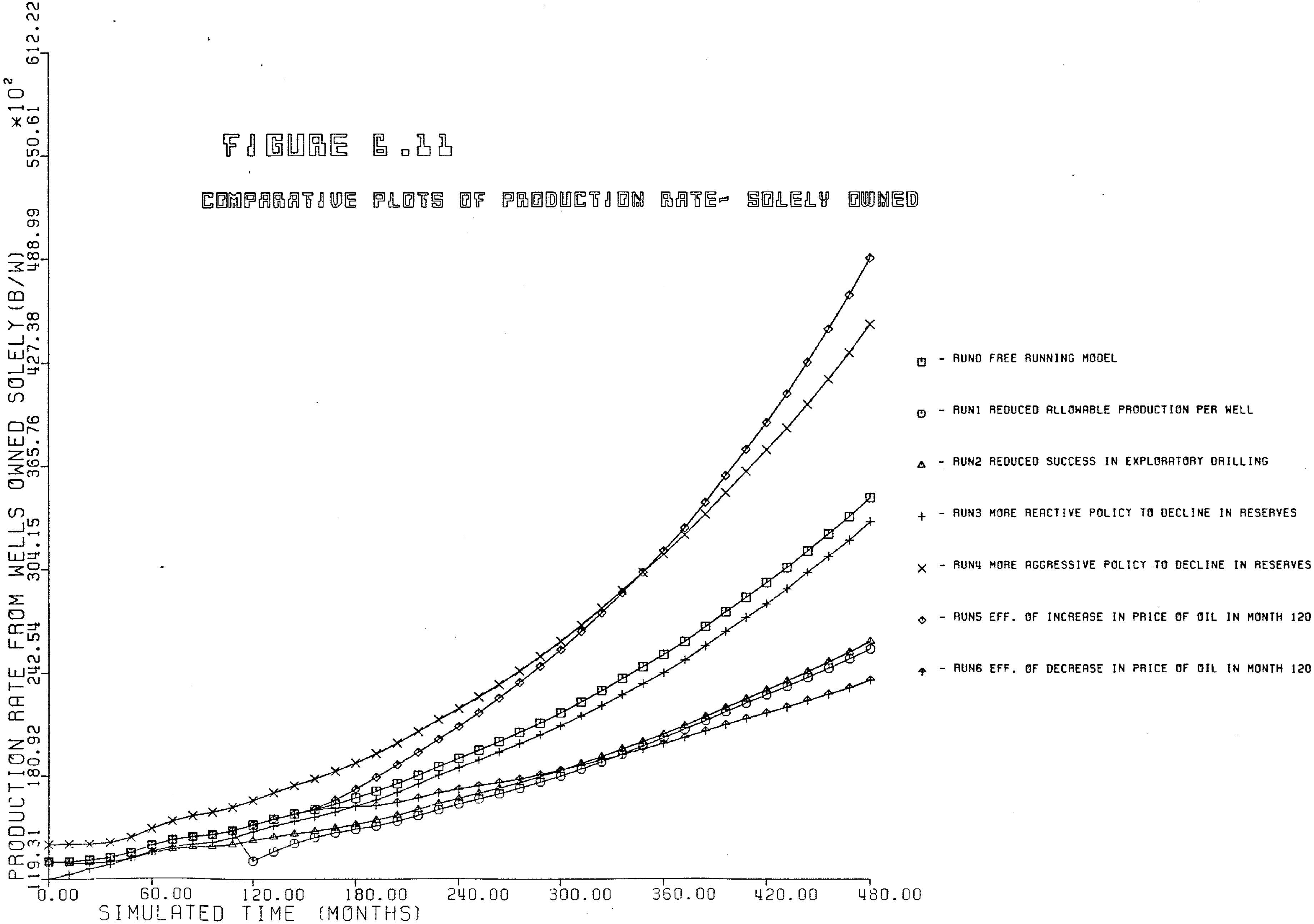
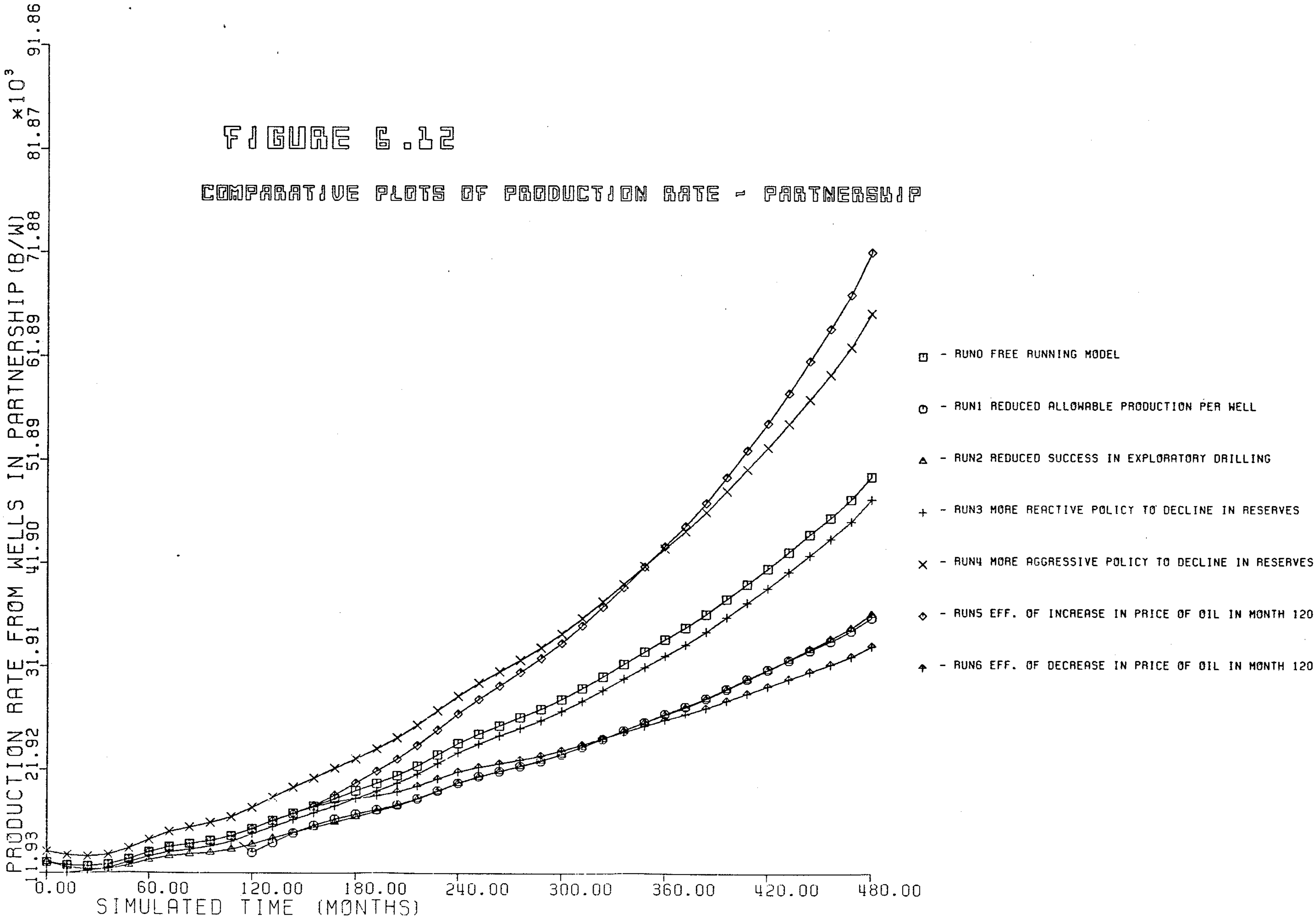


FIGURE 6.11
COMPARATIVE PLOTS OF PRODUCTION RATE- SOLELY OWNED
PRODUCTION RATE FROM WELLS OWNED SOLELY (B/W)
*10²
119.31
180.92
242.54
304.15
365.76
427.38
488.99
550.61
612.22
0.00
60.00
120.00
180.00
240.00
300.00
360.00
420.00
480.00
SIMULATED TIME (MONTHS)
- RUN0 FREE RUNNING MODEL
- RUN1 REDUCED ALLOWABLE PRODUCTION PER WELL
- RUN2 REDUCED SUCCESS IN EXPLORATORY DRILLING
- RUN3 MORE REACTIVE POLICY TO DECLINE IN RESERVES
- RUN4 MORE AGGRESSIVE POLICY TO DECLINE IN RESERVES
- RUN5 EFF. OF INCREASE IN PRICE OF OIL IN MONTH 120
- RUN6 EFF. OF DECREASE IN PRICE OF OIL IN MONTH 120

FIGURE 6.12

COMPARATIVE PLOTS OF PRODUCTION RATE - PARTNERSHIP



Analysis of the results of the various runs:

By going through the comparative plots of the various runs as shown in Figures 6.1 - 6.12 the following observations are noted:

1. Run 6 exhibits the worst performance in the various performance parameters after year ten, and run 5 gives the best performance after year ten. These results show that oil price is the most crucial factor in determining the profitability of the oil company. This aspect agrees favourably with the general behavior of the oil industry. The raising of oil prices increases sharply the cash flow of the company (it is assumed that the company can sell all it produces at whatever the market price, which is not unrealistic in the current oil industry situation), which in turn enables the company to release significantly more money for exploration, resulting in more successful development and thus more producing wells being built. This boosts up the production rate. Although the total proven reserves are being depleted by the production, the addition of proven reserves as a result of the more active exploration activities more than compensates for the loss of the total proven reserves through the increased production. As a result the total proven reserves also increase throughout the simulated period. The depressing performance as exhibited in run 6 can be explained by the fact that the cash flow is generally too low (as a result of the low after tax profit) to maintain a proper exploration program, which is the most vital activity of an oil company. Oil is a depletable product requiring continuous exploration to replenish it. This causes a stagnation of the company. The best control policies could not help to check the deteriorating performance if there is not enough cash flow to start with.

2. In run 2, the success rate of the exploratory wild cat wells drilled solely as well as under partnership are assumed to be 10 percent as compared to the national average of 15 percent in the normal run. As expected, this causes a dramatic deterioration in the system performance as compared to the normal run and does not need much explanation. It is seen that the exploratory drilling rate in run 2 is generally higher than in run 1 though the total proven reserves in run 2 is significantly lower than those in run 1. The gap becomes more prominent as the years pass by. There is almost no discernible difference in the long term average production rate between run 1 and run 2. These behaviors can be explained by noting that in run 2, as a response to the falling reserves, the company releases more funds for exploration in the hope of checking its falling reserves and to maintain its life horizon. Furthermore, the exploration funds come from the cash flow and there is not much difference in the cash flow between run 1 and run 2. The result is that the exploratory drilling rate is higher in run 2 than in run 1. Unfortunatley the success rate for exploratory drilling (wild cat wells) in run 2 is lower than in run 2 (10 percent versus 15 percent), this results in a lower number of wells being successfully developed over the years for run 2 as compared to run 1. Since the producing wells come from the successfully developed wells, we see from figure 6.6 that the total producing wells in run 2 is lower than in run 1. The long term average production rate is similar for run 1 and run 2 because, in run 1, the quota of allowable production rate after the tenth year is lower thus effectively restricting its production rate. Now since run 1 has signifi-

cantly more producing wells than in run 2 with no discernible difference in the production rate, naturally the total proven reserves in run 1 is higher than in run 2 (figure 6.4). Lastly we see that over the years the cash flow for run 1 is similar to run 2. This is because

(a) run 1 and run 2 have similar production rate generating more or less the same revenue
(b) run 2 has higher exploration cost associated with the higher exploration rate and the lower development cost associated with the lower development rate due to low success rate in exploratory wild cat drilling. On the other hand, run 1 has lower exploration cost associated with the lower exploratory drilling rate and the higher development cost associated with the higher development rate. The net effect is a similar total cost.
(c) The production cost is almost the same due to similar production rate.
(d) Other expenses are insignificant compared to the exploration, development and production cost.

The net effect is the similarity in the cash flow.

3. Run 3 represents an increase in the sensitivity to reserves whereby the company adjusts its production rate by a bigger margin in response to its actual life horizon, as compared to the normal run (run 0). Interestingly it is noted that in this run the performance is worse than in run 0 in terms of the total proven reserves, cash flow, long

term average production rate, total producing wells, after tax profit and the return on investment. Overall the system behaves quite simi-larily to run 1 and run 2. A possible explanation of this behavior in run 3 might be that as the company tries to release more funds for exploration in response to the perception of its actual life horizon, the amount of funds released is not large enough to have any significant impact on the exploration rate, thus the number of new successful exploratory wells only increases marginally and so does the number of new producing wells. Now the total proven reserves is being depleted by the production and with no significant addition of new successfully developed wells, the company, in order to maintain its life horizon, reduces the production rate too drastically which reduces the revenue. The reduction in revenue in turn brings down the cash flow and thus the funds for exploration. The cycle thus repeats. This suggests that the company needs to exercise a more careful balance in the controlling of production rate and allocation of exploration funds. This leads to run 4.

4. In run 4 the company adopts a more aggressive policy. It shows a dramatic improvement in the various performance parameters over the other runs and even compares favourably with run 5. It is seen that in run 4, the average production rate and the proven reserves increase sharply over the years as compared to the rest. The return on investment remains at a healthy 12 percent, which is the oil industry's average. In this run, the company is able to generate a healthy cash flow from its production, enabling it to embark on more ambitious exploration program. The exploration activity pays off nicely result-

ing in significant addition of successfully developed wells. Although the company does react to its changing reserves by adjusting its exploration funds, the amount of funds released more than compensate for the risk involved in exploration. All in all, barring the uncontrollable force of oil price fluctuations and exceptional success rate, run 4 gives the best performance compared to the other runs.

Some Concluding Remarks

The above experiments are not meant to give definite answers, but are chosen to stimulate thought, so that the interested readers might be encouraged to experiment further to find the most desirable policies under varying constraints.

CHAPTER 7

CONCLUSIONS AND IMPLICATION

This thesis has described the development and application of a continuous simulation feedback model to an investigation of the dynamic relationships governing production, proven reserves, cash flow, return on investment and other financial factors in a hypothetical independent oil company. There is need for analytical approaches to aid understanding of the many complex issues involved. It has been demonstrated how the model is capable of aiding such understanding. By its ability to link together exploration, production, information and cash flows, it has considerable potential for policy design at all levels of an organization and it is capable of reducing difficult concepts to easily understandable graphical results of trends through time. These dynamic facilities give the method a significant advantage over other methods of aggregate financial analysis. Alternatively, the model can be turned into a research or training game where the participants make the policy decisions, and the simulation model generates the performance indices upon which the next round of decisions will be made (Hall, 1973). Gaming Dynamo (Pugh-Roberts Associates) is an appropriate simulation language for this purpose. Hopefully by experimenting with the model, the oil executives could gain valuable insight and search for policies that will not only counter deteriorating system behavior but will also be robust against uncontrollable shocks on the system (Hall, 1980).

One of the major assumptions in the model is that all the capital for exploration, development, production and other expenses were derived from internally generated cash flows. This might be unrealistic in real life situations where the oil companies borrow heavily to finance its operations. This suggests that the model could be expanded to incorporate ideas on the financial aspects. More specifically, the model does not include

(1) Long-term debt financing

(2) Earnings cover for interest charges

(3) Short-term liquidity ratio and the proportion of long term and short term finance (See H. Shehata, 1976).

Moreover the taxation is treated very simply.

The author feels that none of the above aspects are particularly difficult to model in the sense of calculating the required quantities--the major difficulty lies in discovering how they are used in corporate policies. According to circumstances this can be approached by doing a case study in an actual oil company. Quite often it is not necessary to make a very detailed and complicated model of the company to trap the essence of the real-world phenomenon. It is thus hoped that the oil company planners could be interested to take this embryonic model, expand on the financial sector and/or other sectors which they are particularly concerned, adapt it to their own organizations and use it either for their planning purposes or as a training aid.

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APPENDICES

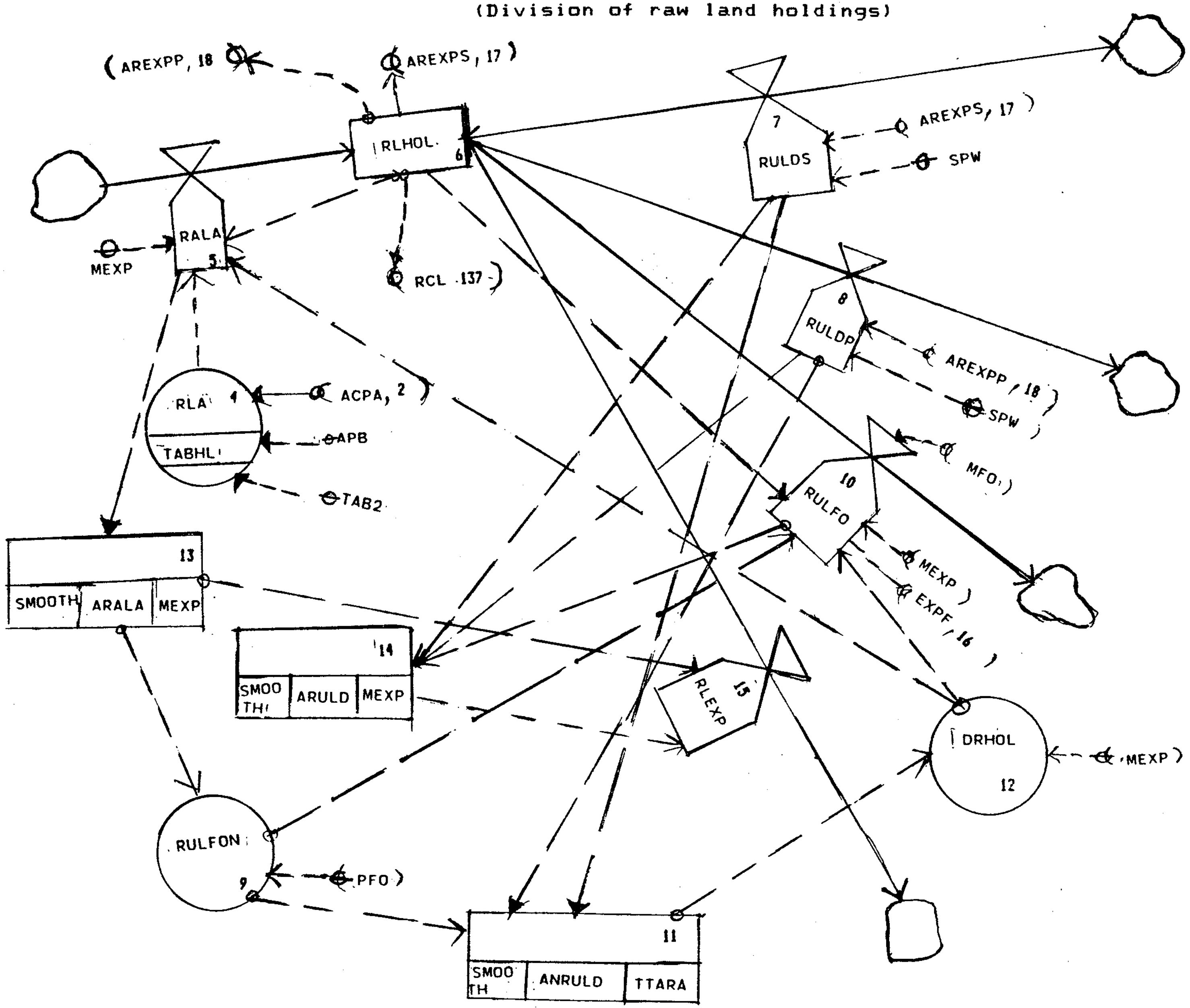
A System flow diagrams

B A listing of the equations of the model in the DYNAMO system simulation language

C Alphabetic listing of variables and their definitions and cross-reference to where used

LEASE SECTOR

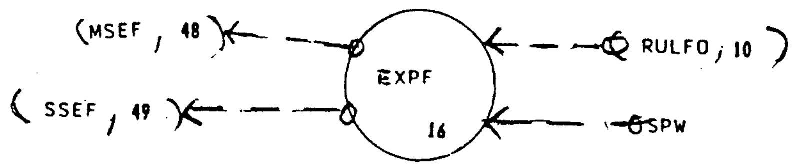
(Division of raw land holdings)

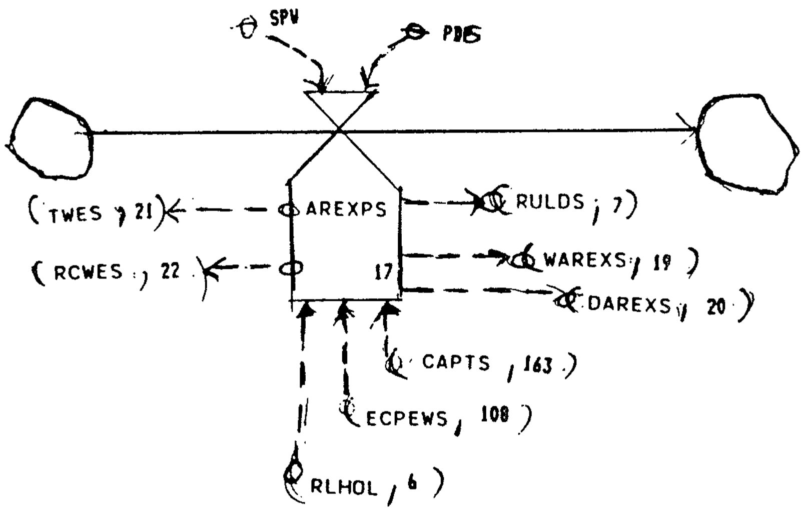


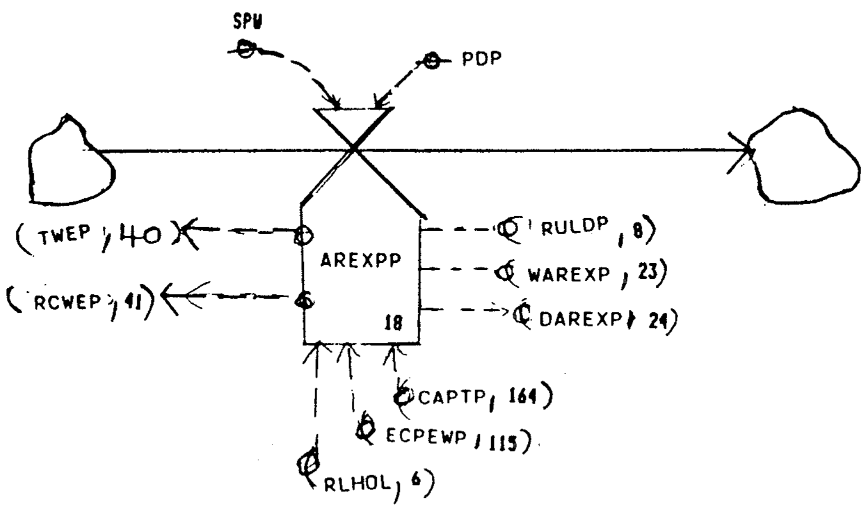
A2

EXPLORATION SECTOR

(Exploration rates of raw land holdings)



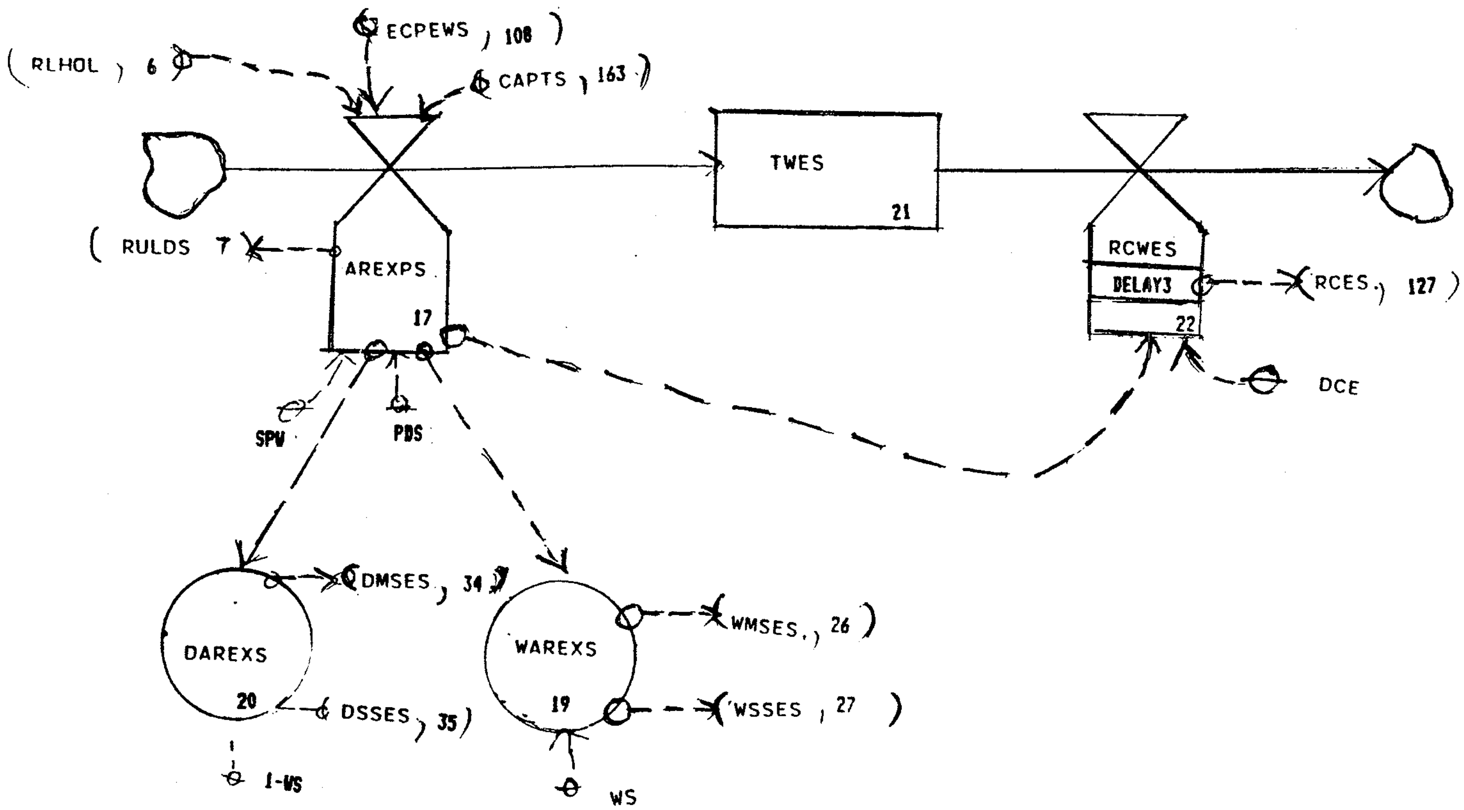




A3

EXPLORATION SECTOR

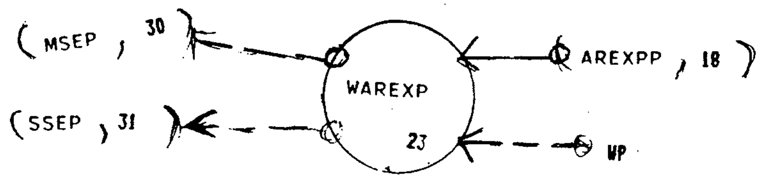
(Rate of drilling wildcat & development wells solely by company)

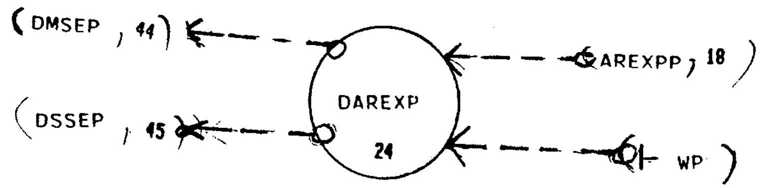


A4

EXPLORATION SECTOR

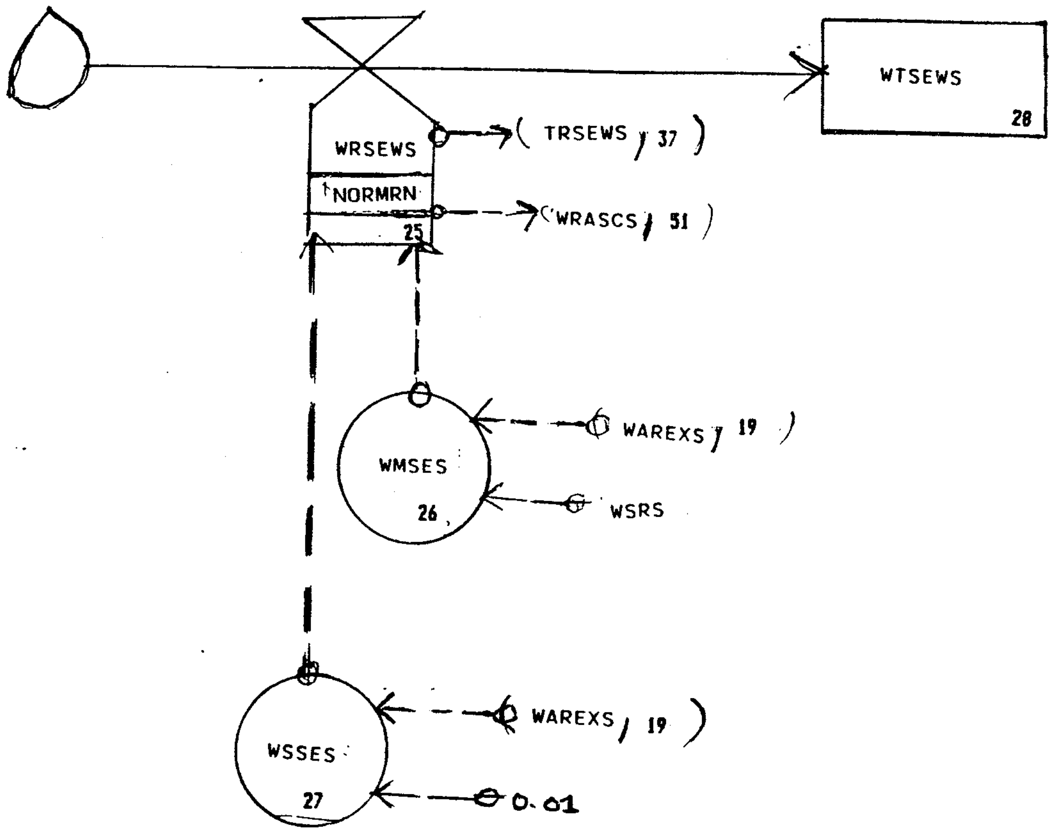
(Rate of drilling under partnership)





EXPLORATION SECTOR

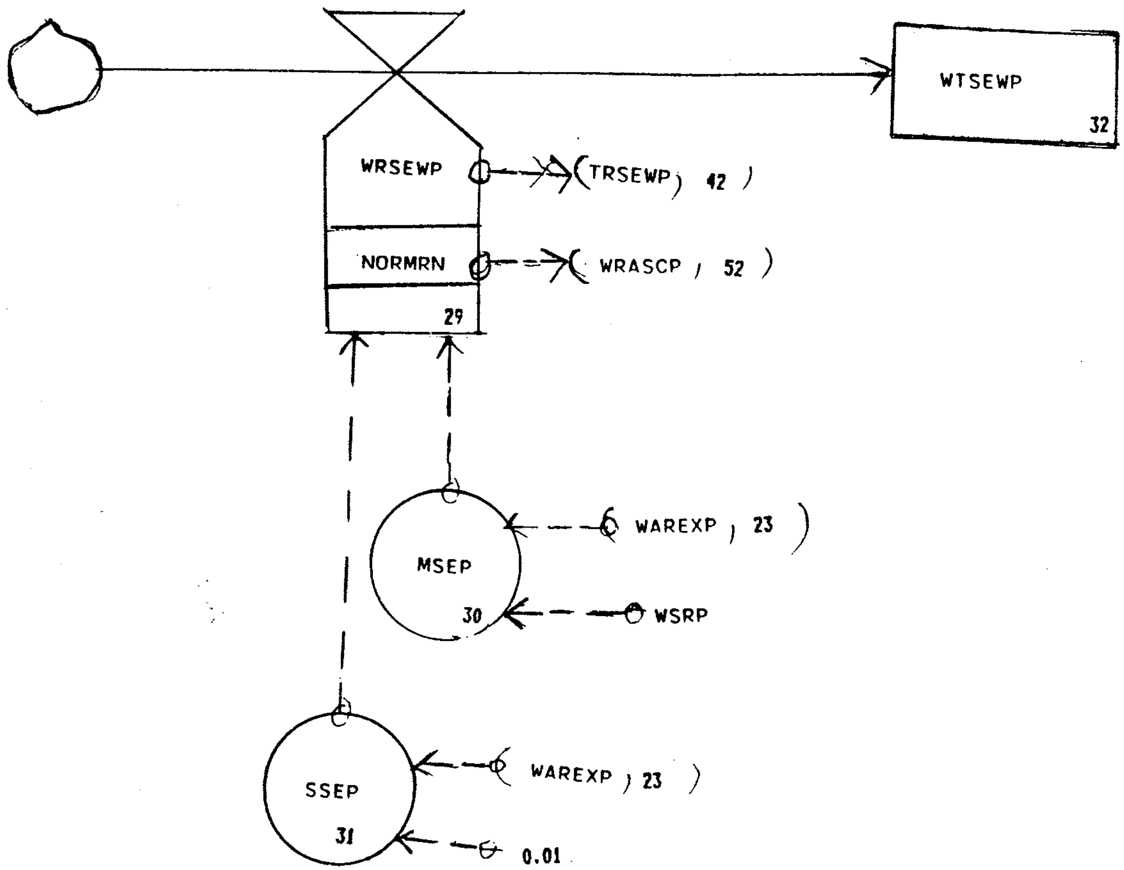
(Success in drilling exploratory wildcat wells solely by company)



A6

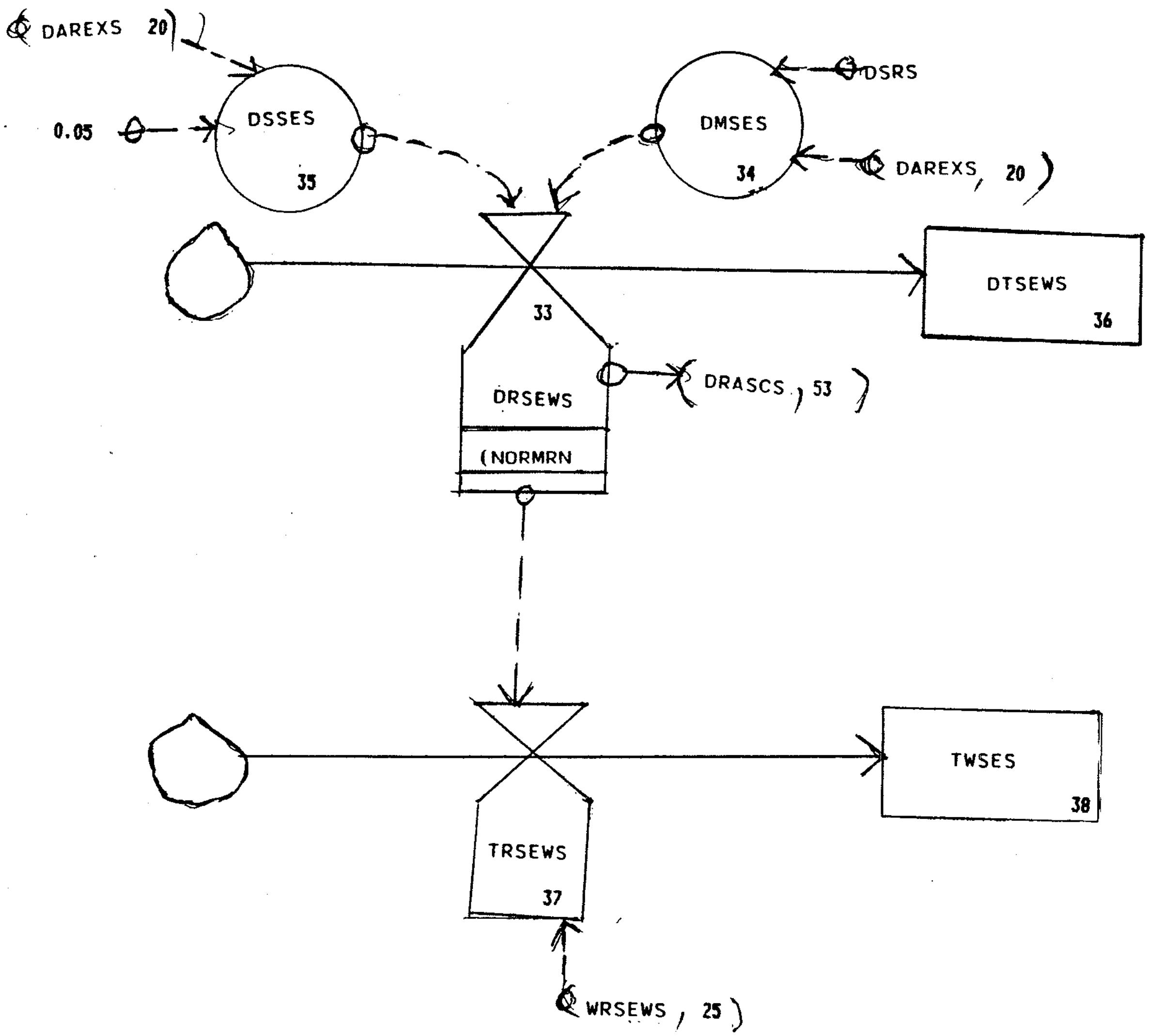
EXPLORATION SECTOR

(Success in drilling exploratory wild cat wells under partnership)



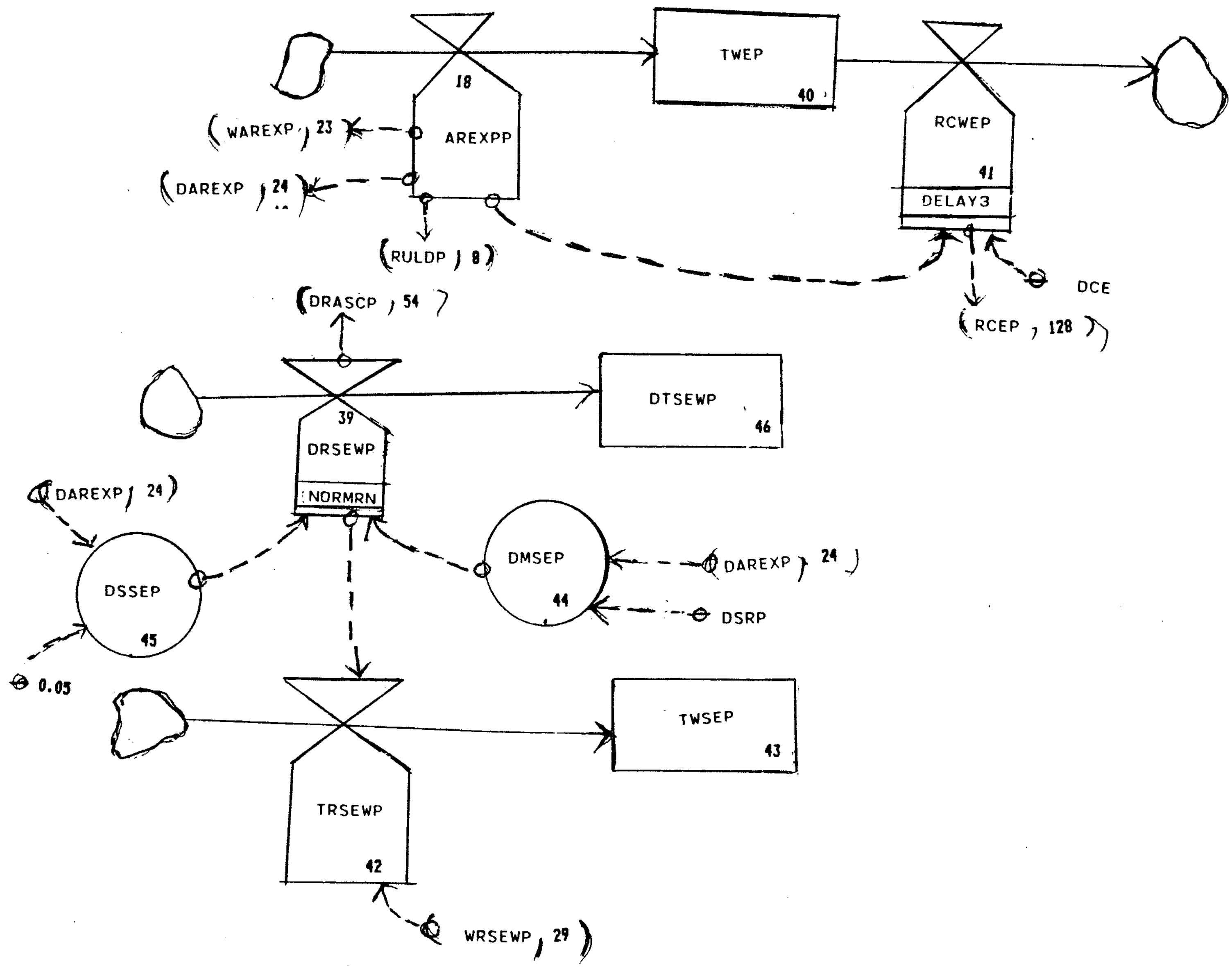
EXPLORATION SECTOR

(Success in drilling development wells solely by company)



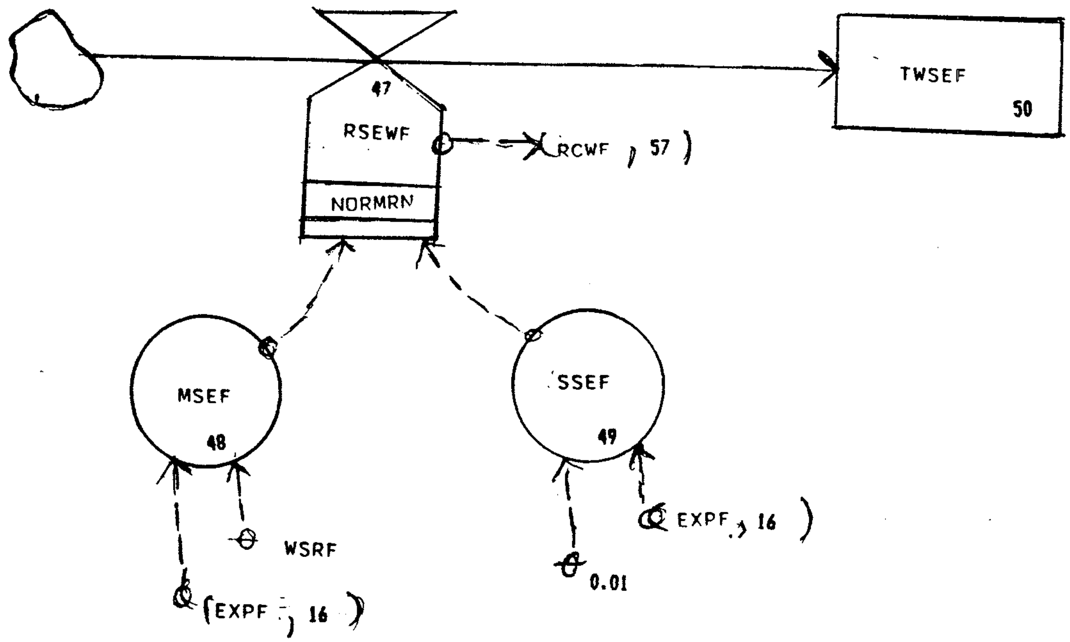
EXPLORATION SECTOR

(Success in drilling development wells under partnership)

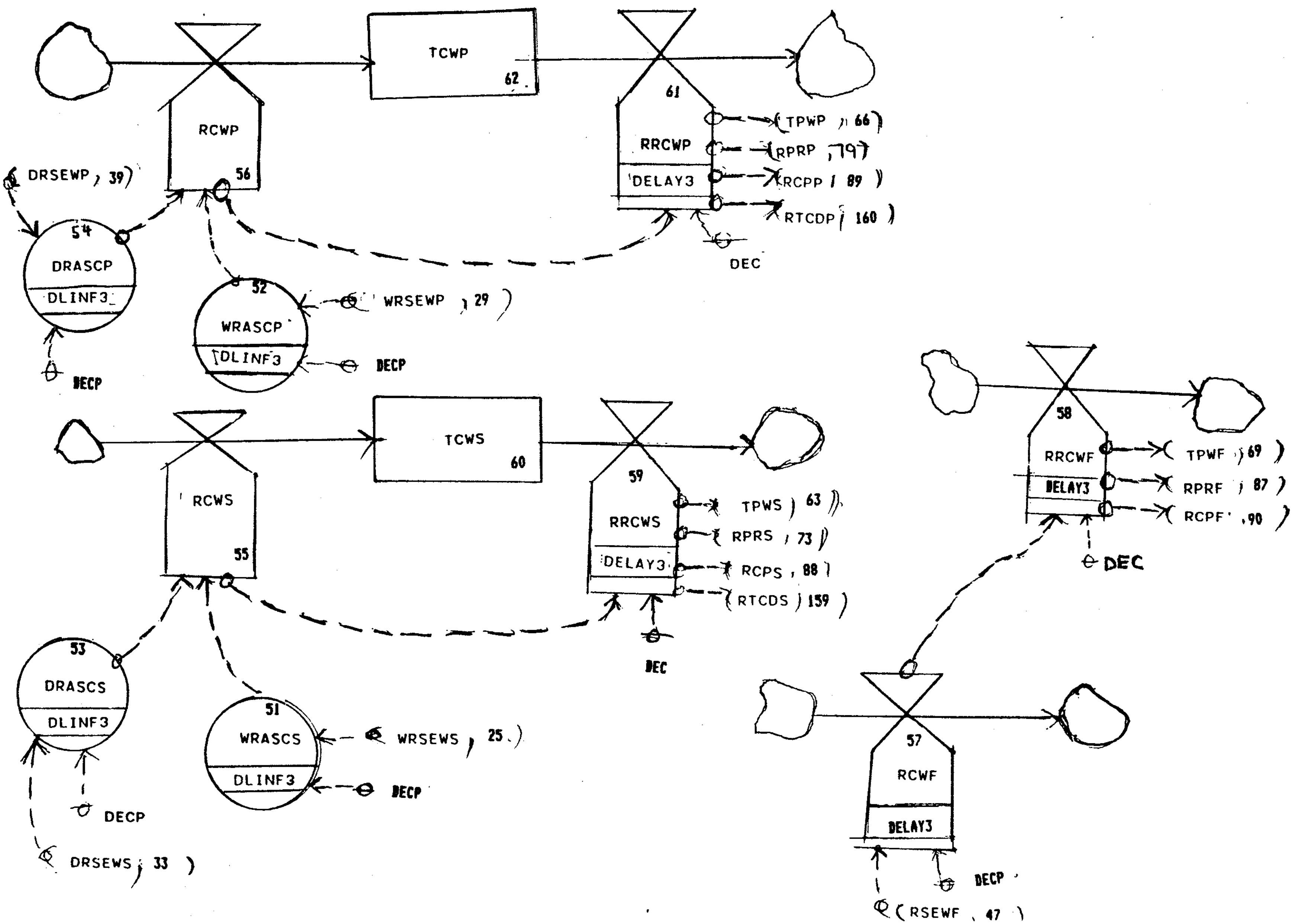


EXPLORATION SECTOR

(Rate of drilling wildcat & development farmed out wells)

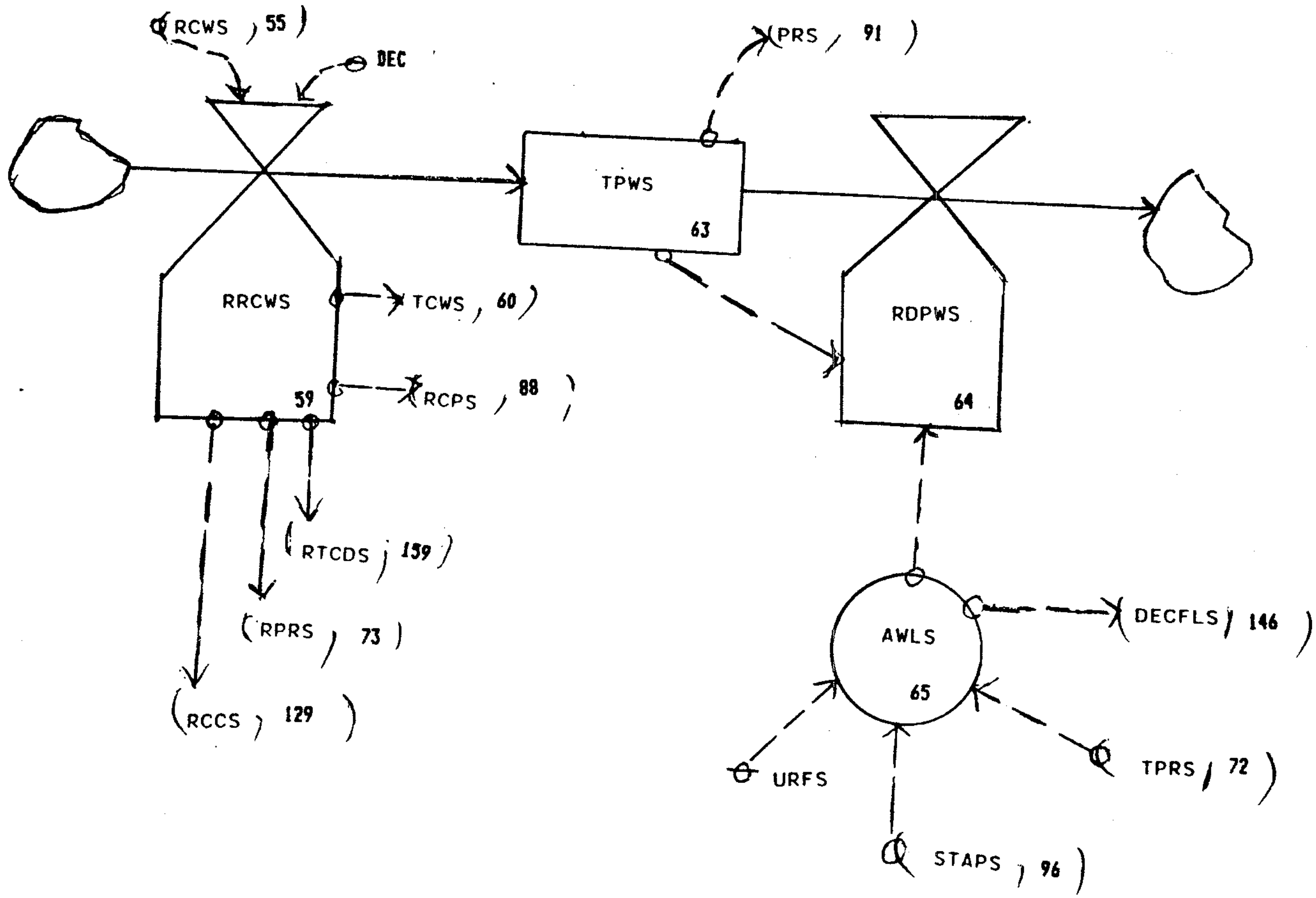


COMPLETION STAGE SECTOR

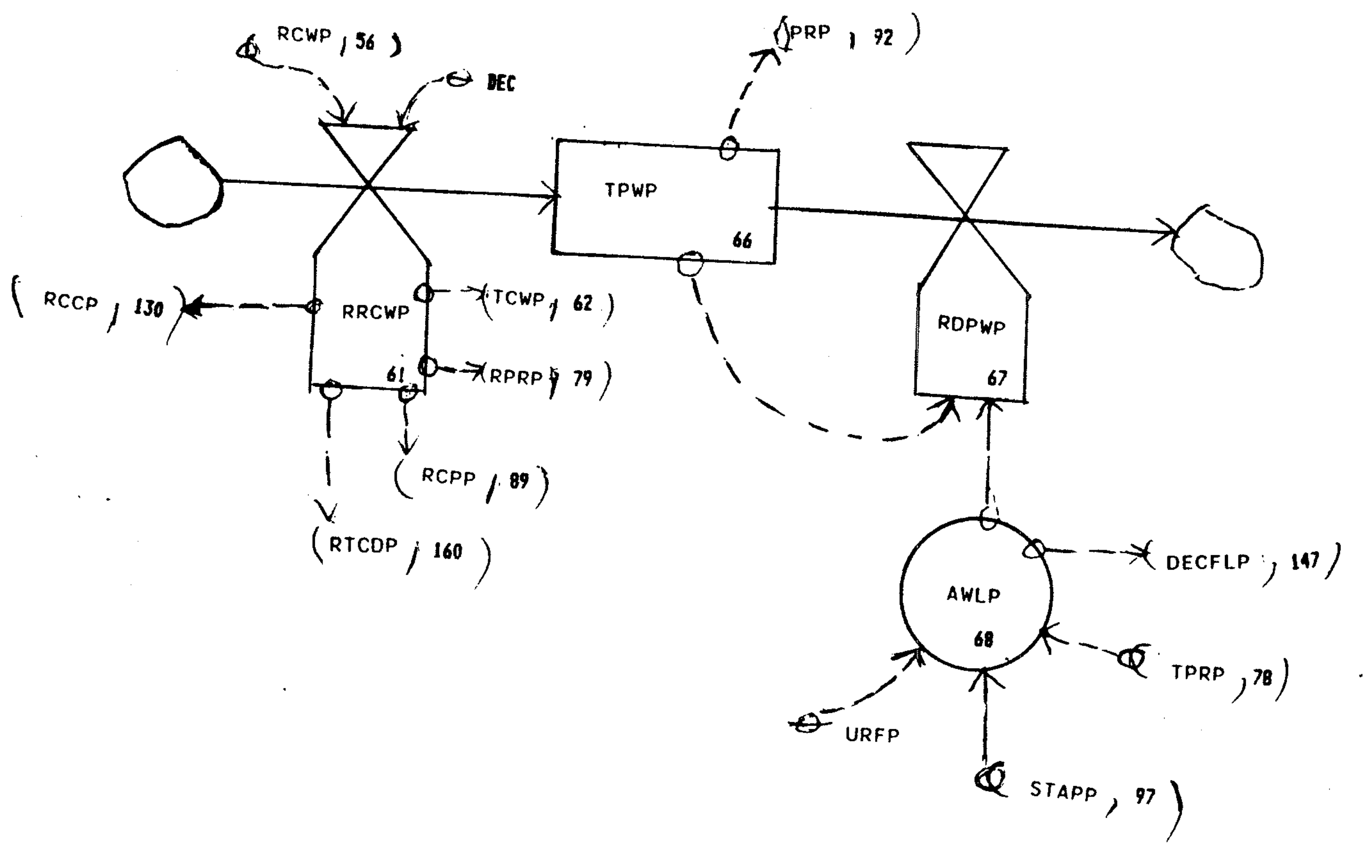


PRODUCING WELLS SECTOR

(Completed solely by company)



PRODUCING WELLS SECTOR
(Completed under partnership)



PRODUCING WELLS SECTOR

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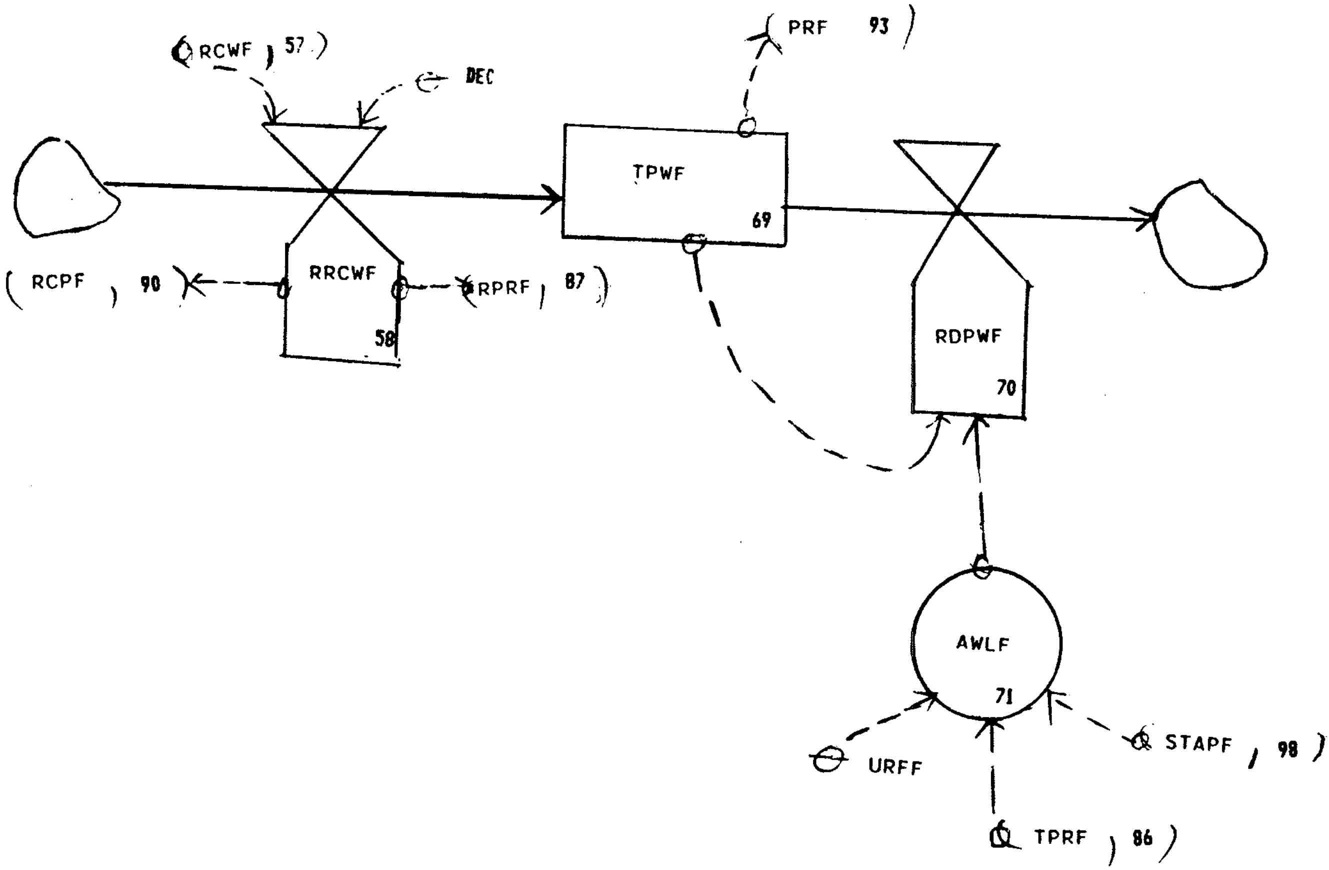
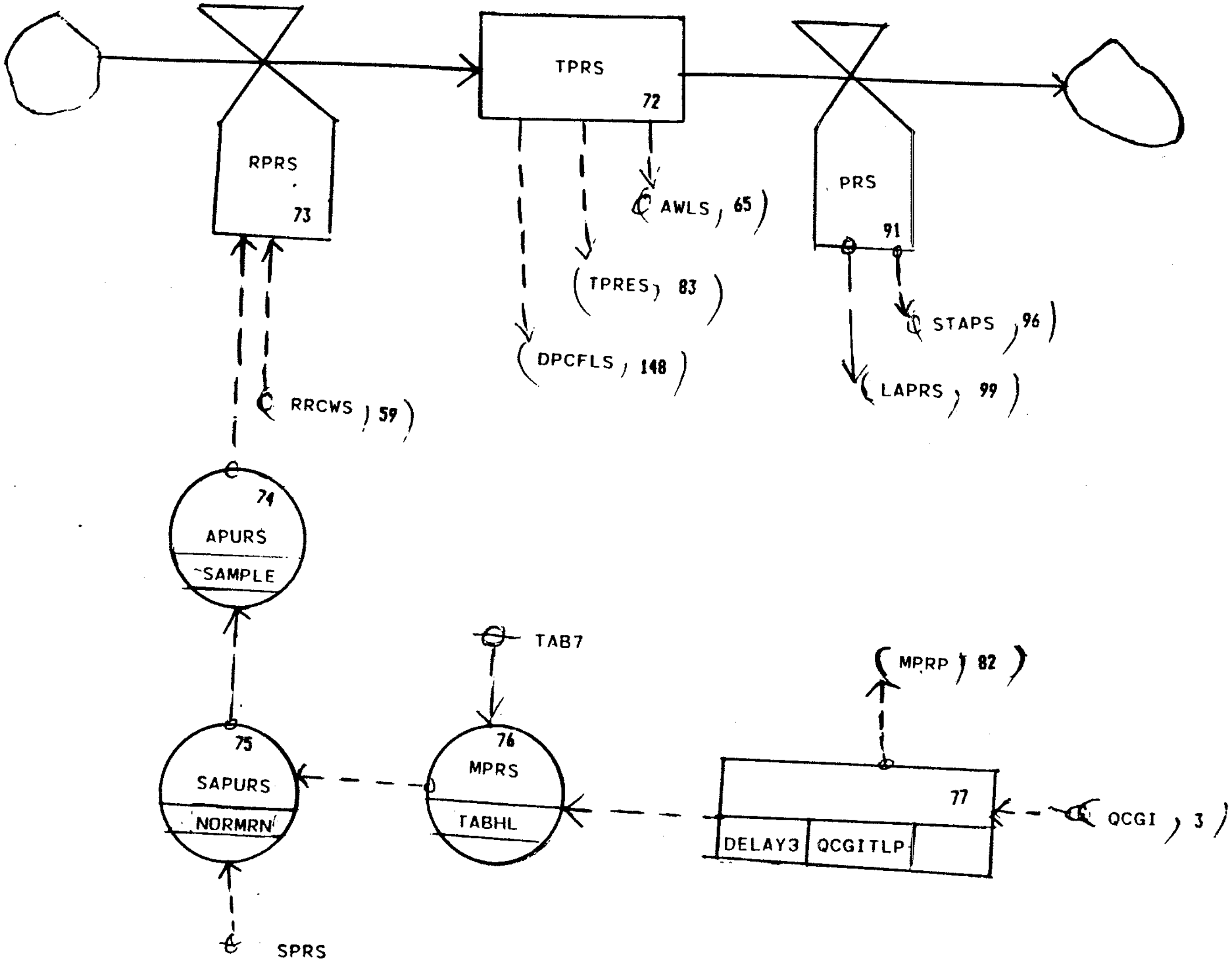


PROVEN WELLS SECTOR

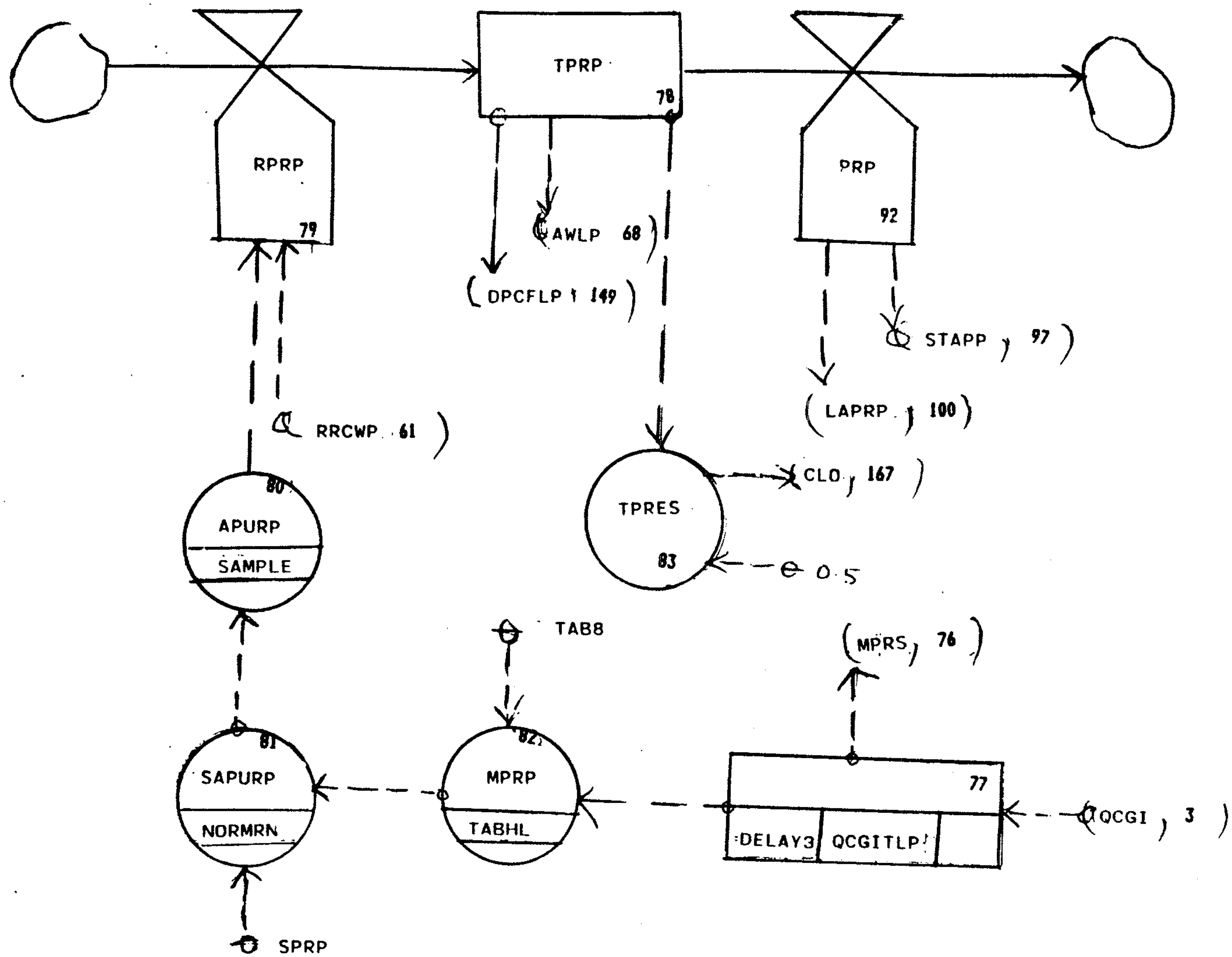
(Completed solely by company)



A15

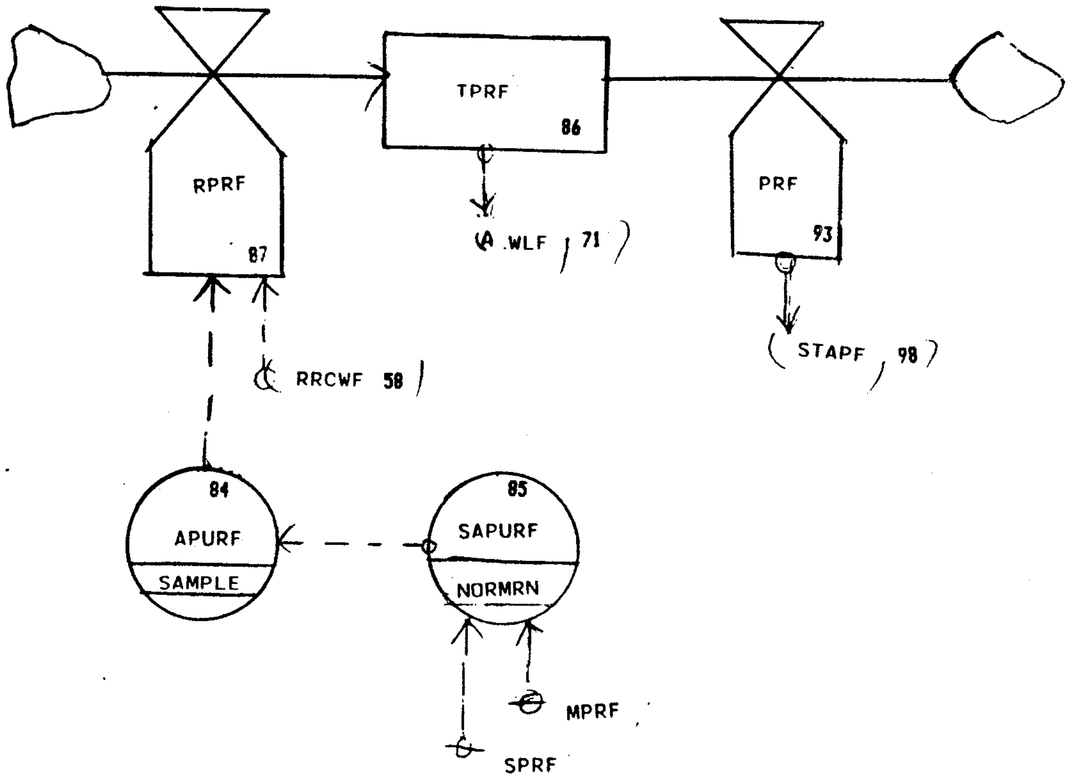
PROVEN WELLS SECTOR

(Completed under partnership)



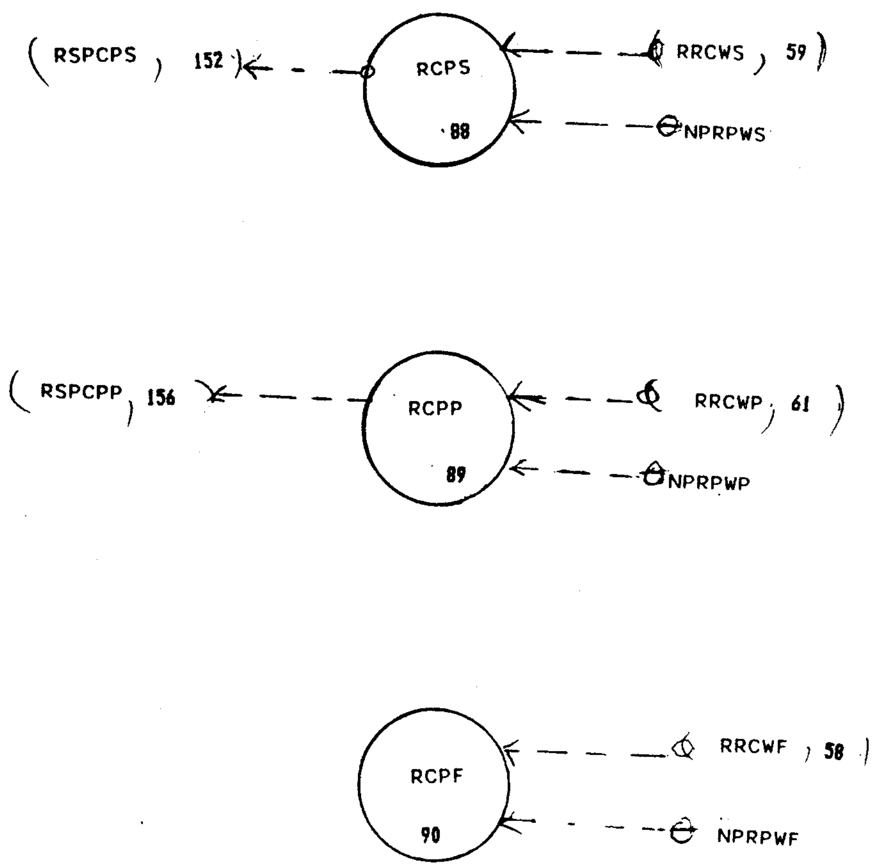
PROVEN WELLS SECTOR

(Completed under farmed out)

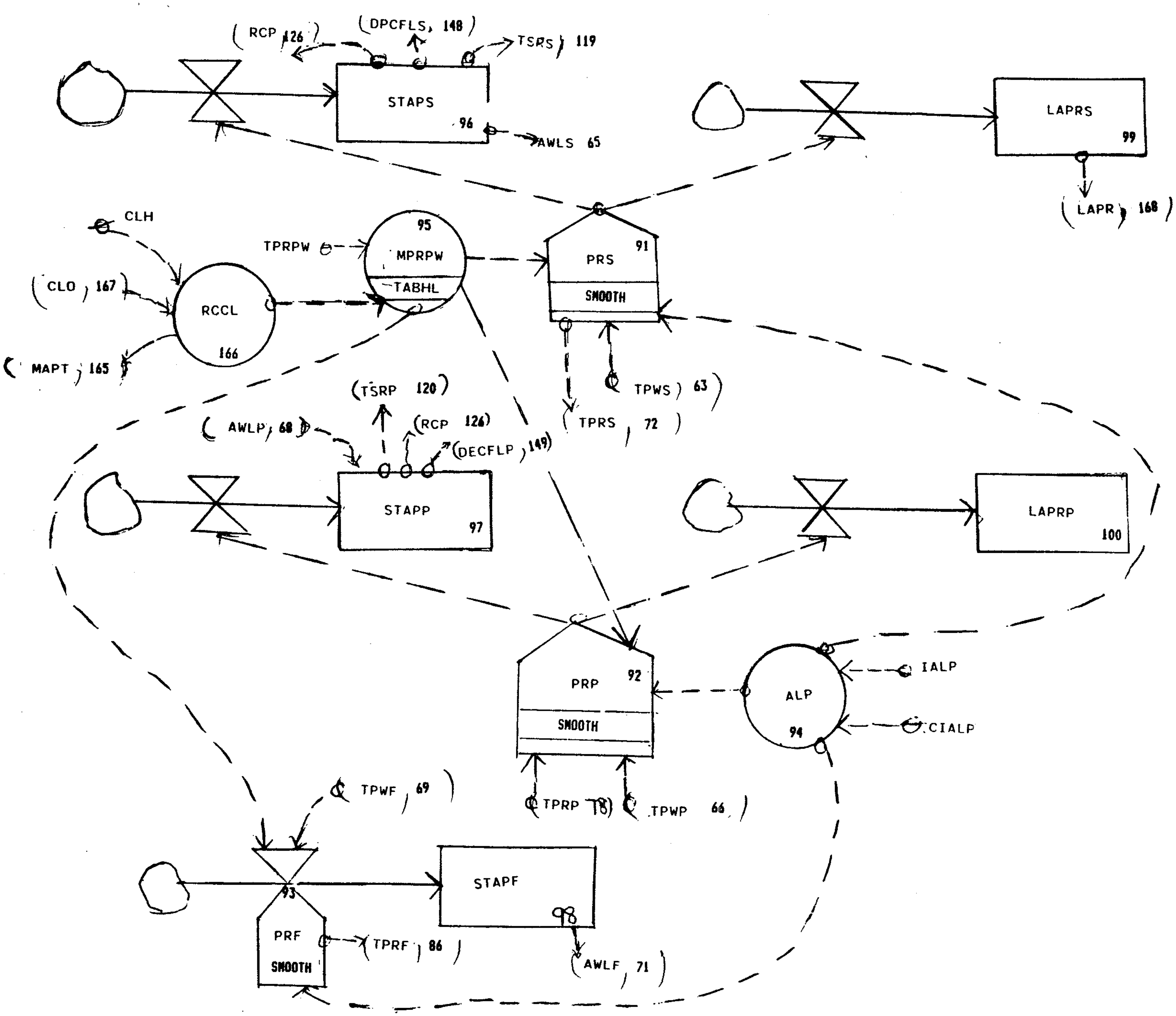


A17

PRODUCTION CAPACITY SECTOR

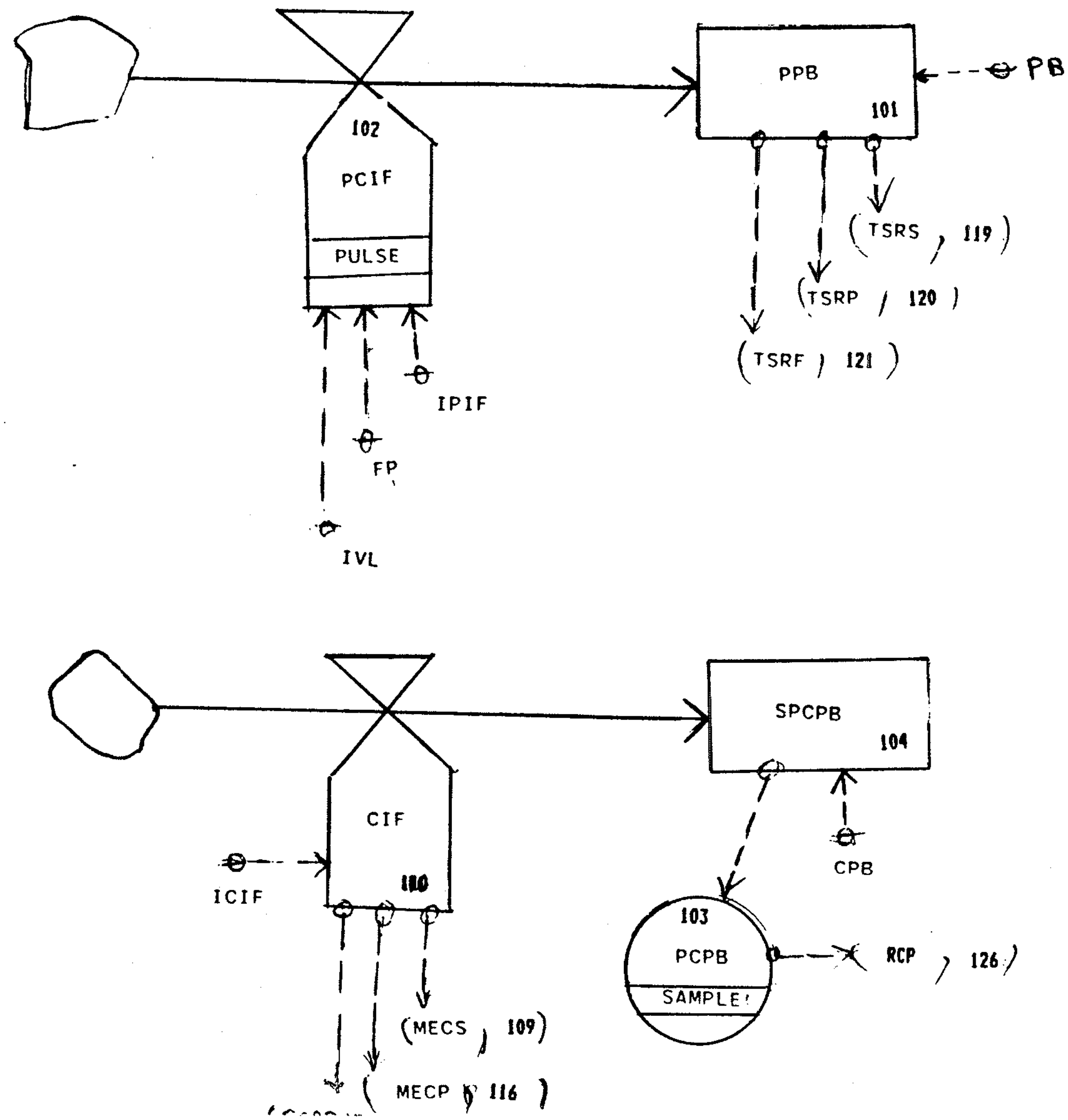


PRODUCTION SECTOR



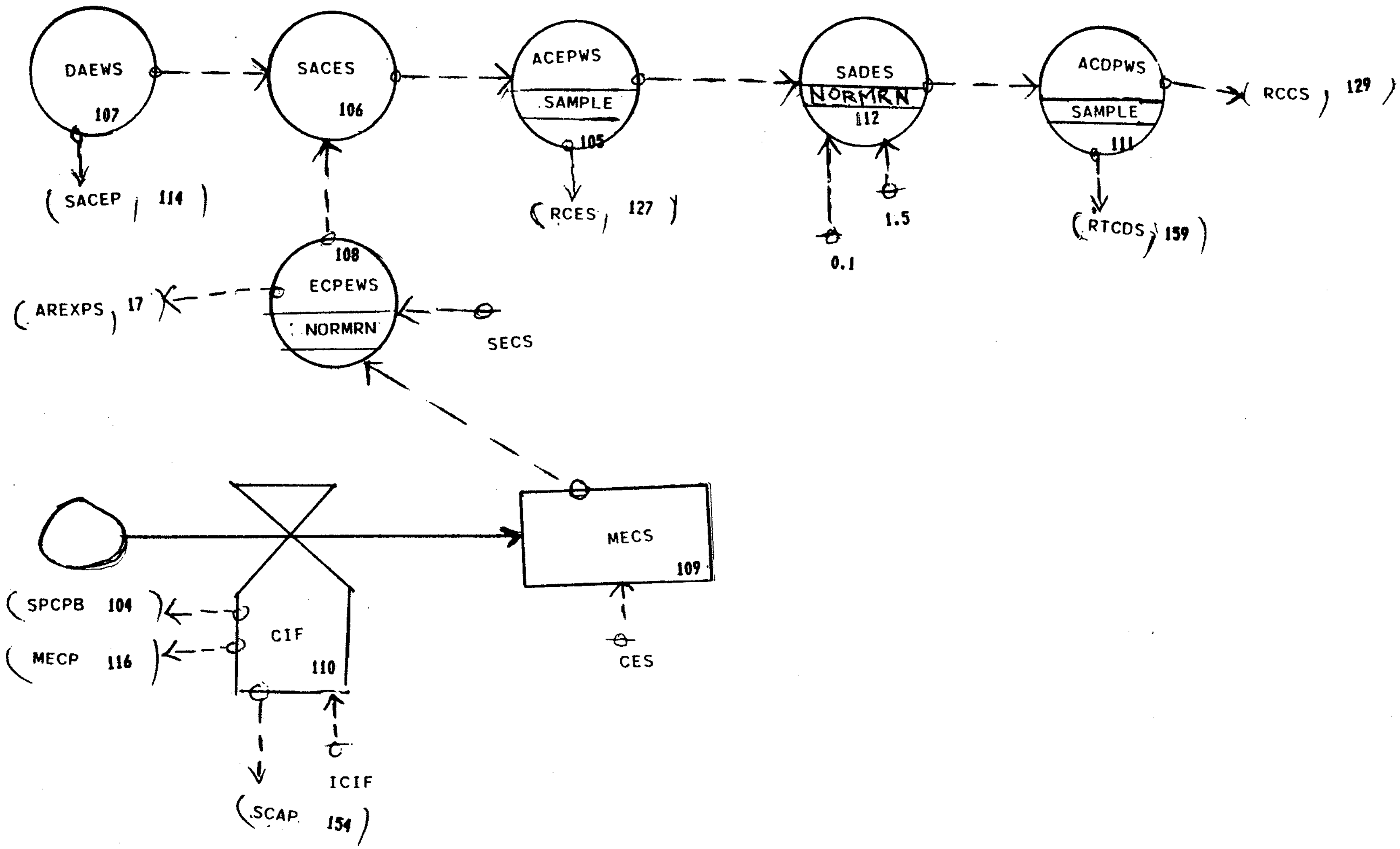
FINANCIAL ACCOUNTING SECTOR

(Price per barrel and cost of production assumptions)



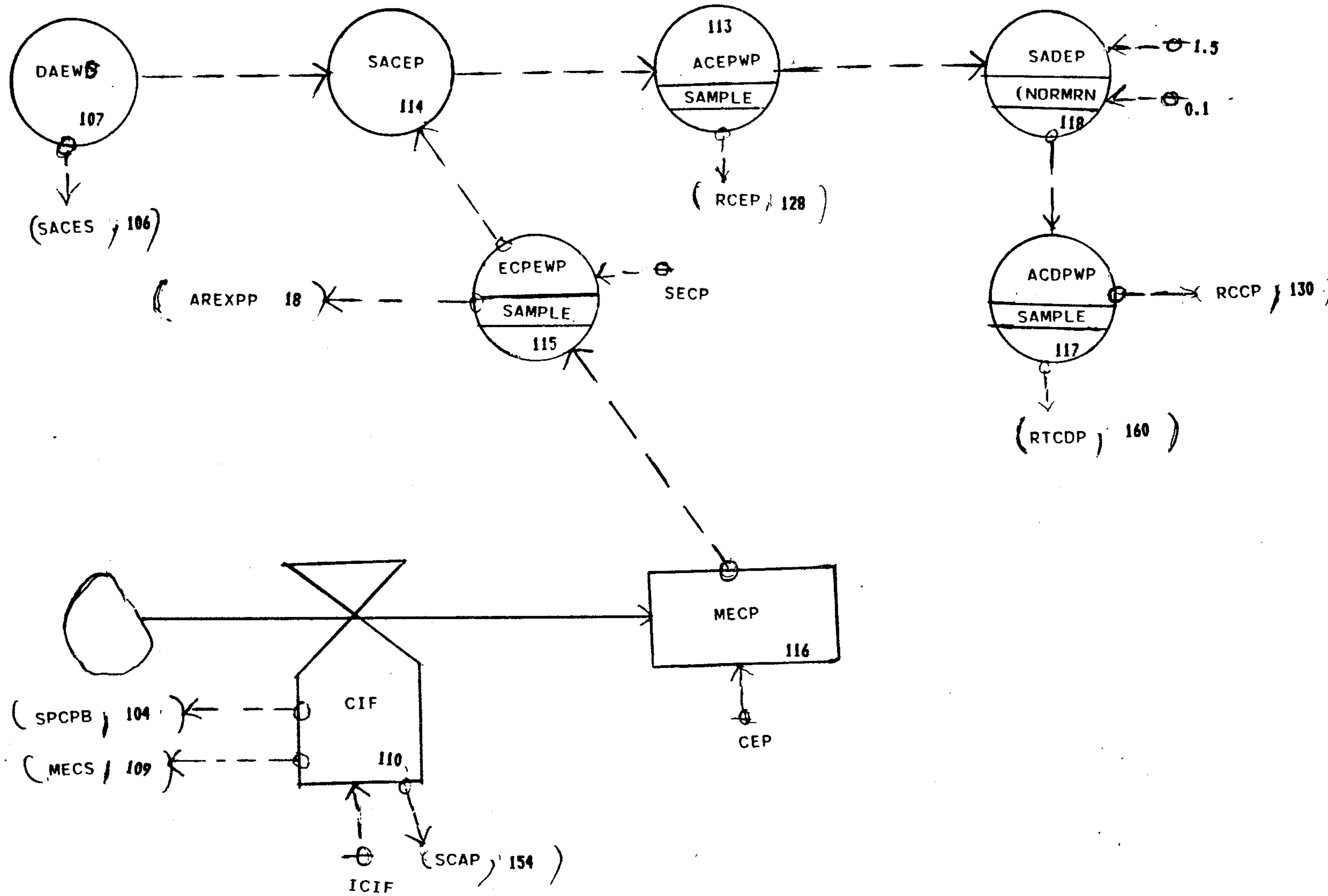
FINANCIAL ACCOUNTING SECTOR

(Exploration and development cost of wells drilled solely by company



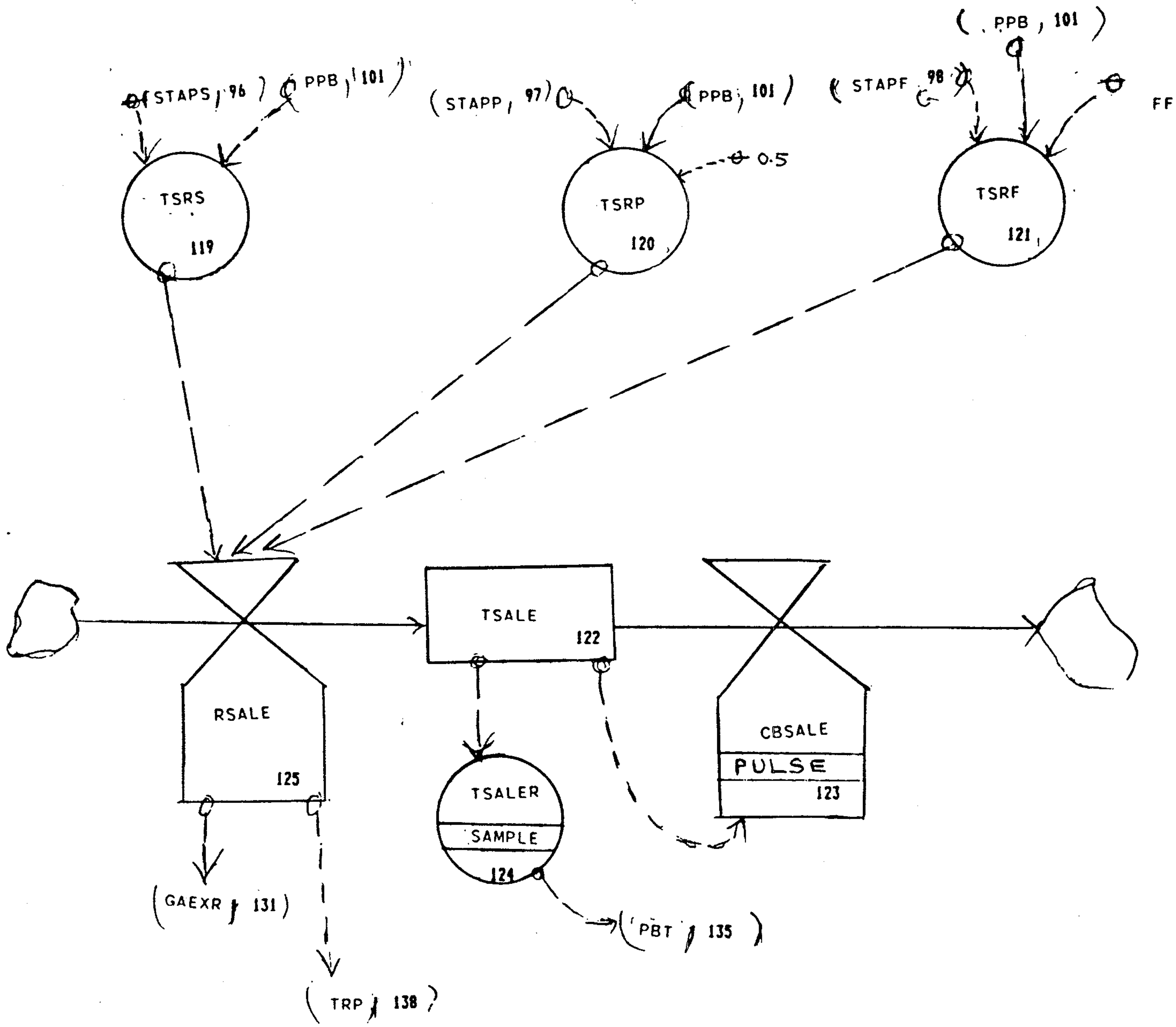
FINANCIAL ACCOUNTING SECTOR

(Exploration and development cost of wells drilled under partnership)



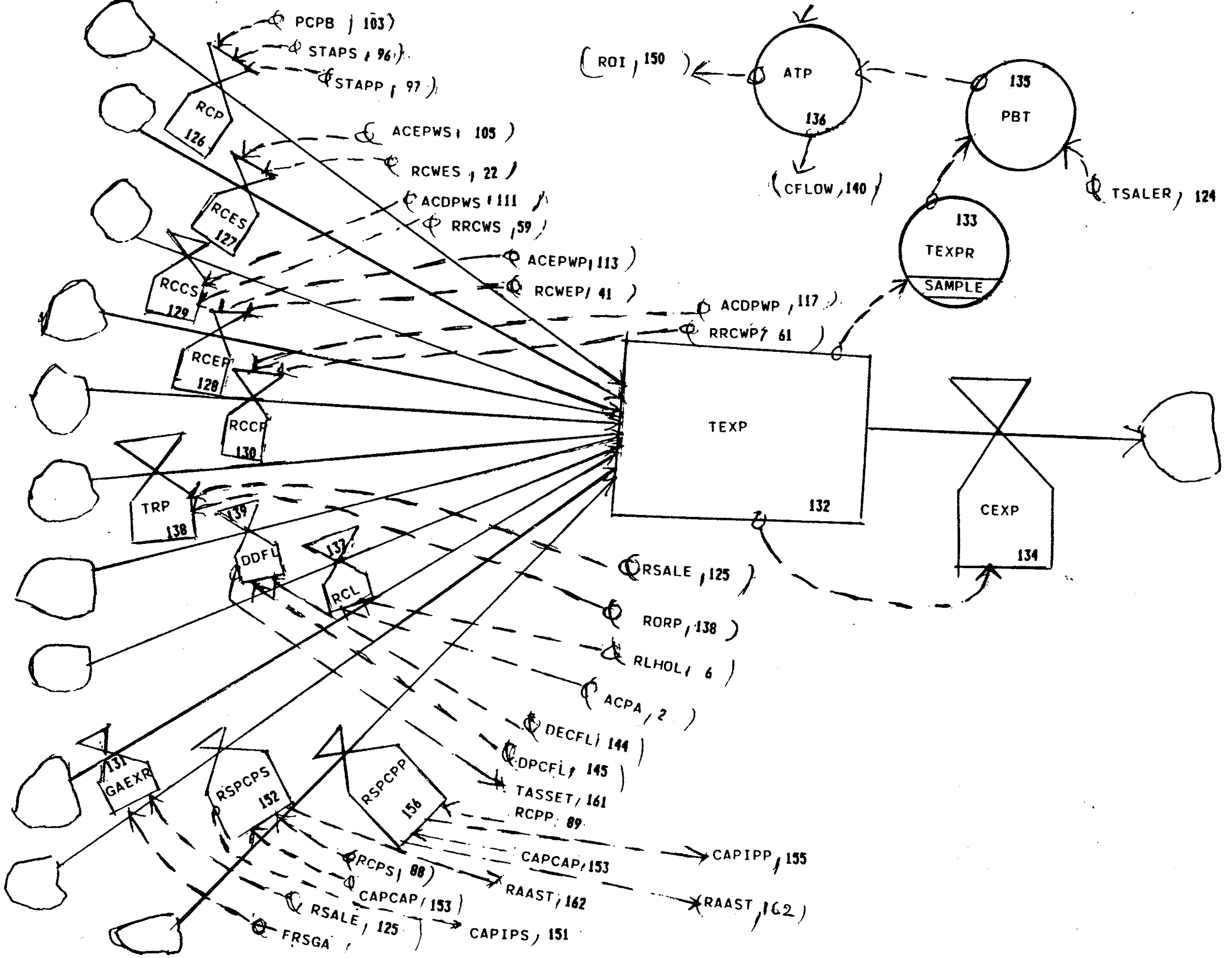
FINANCIAL ACCOUNTING SECTOR

(Operating revenue)



FINANCIAL ACCOUNTING SECTOR

(Operating expenses)



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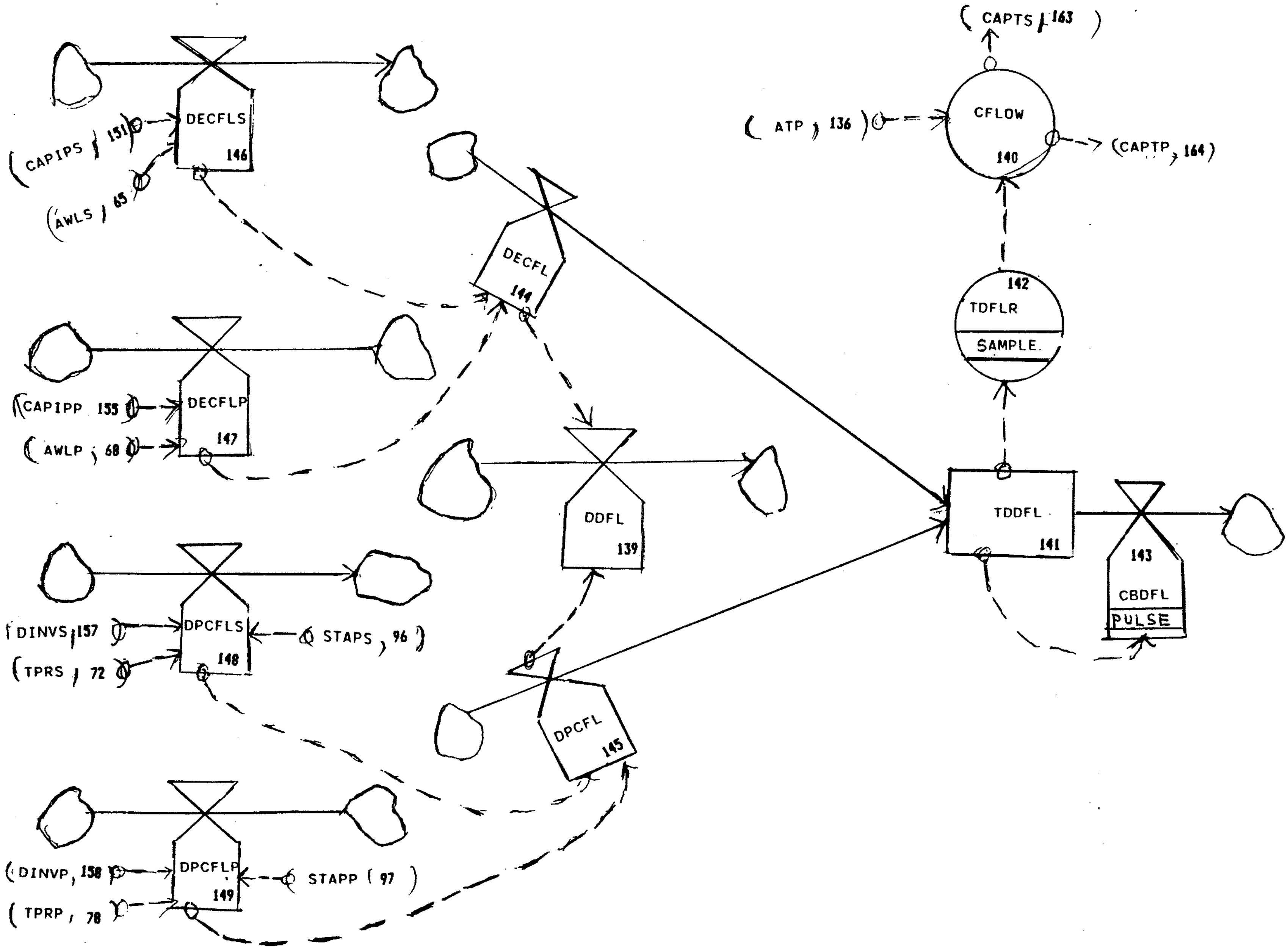
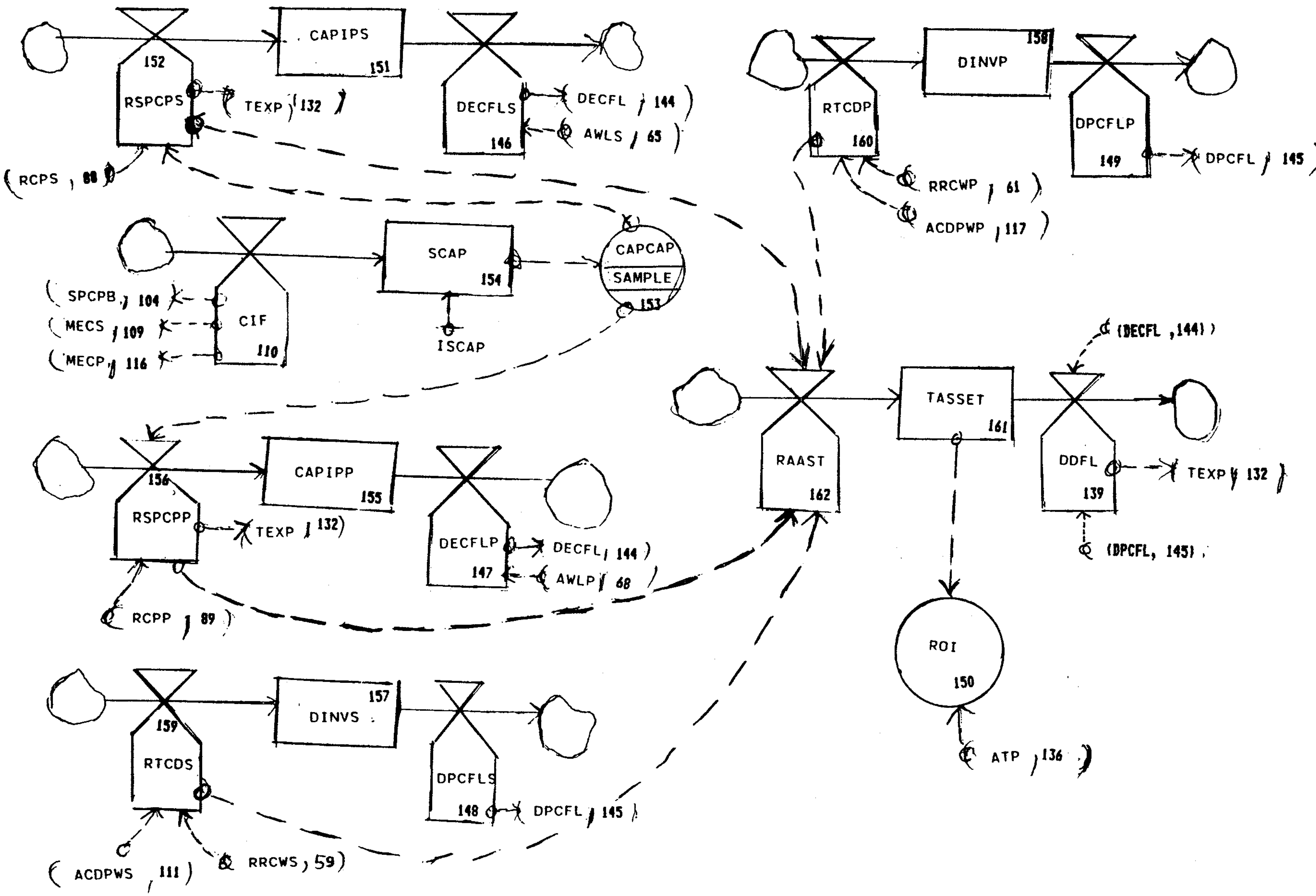
FINANCIAL ACCOUNTING SECTOR

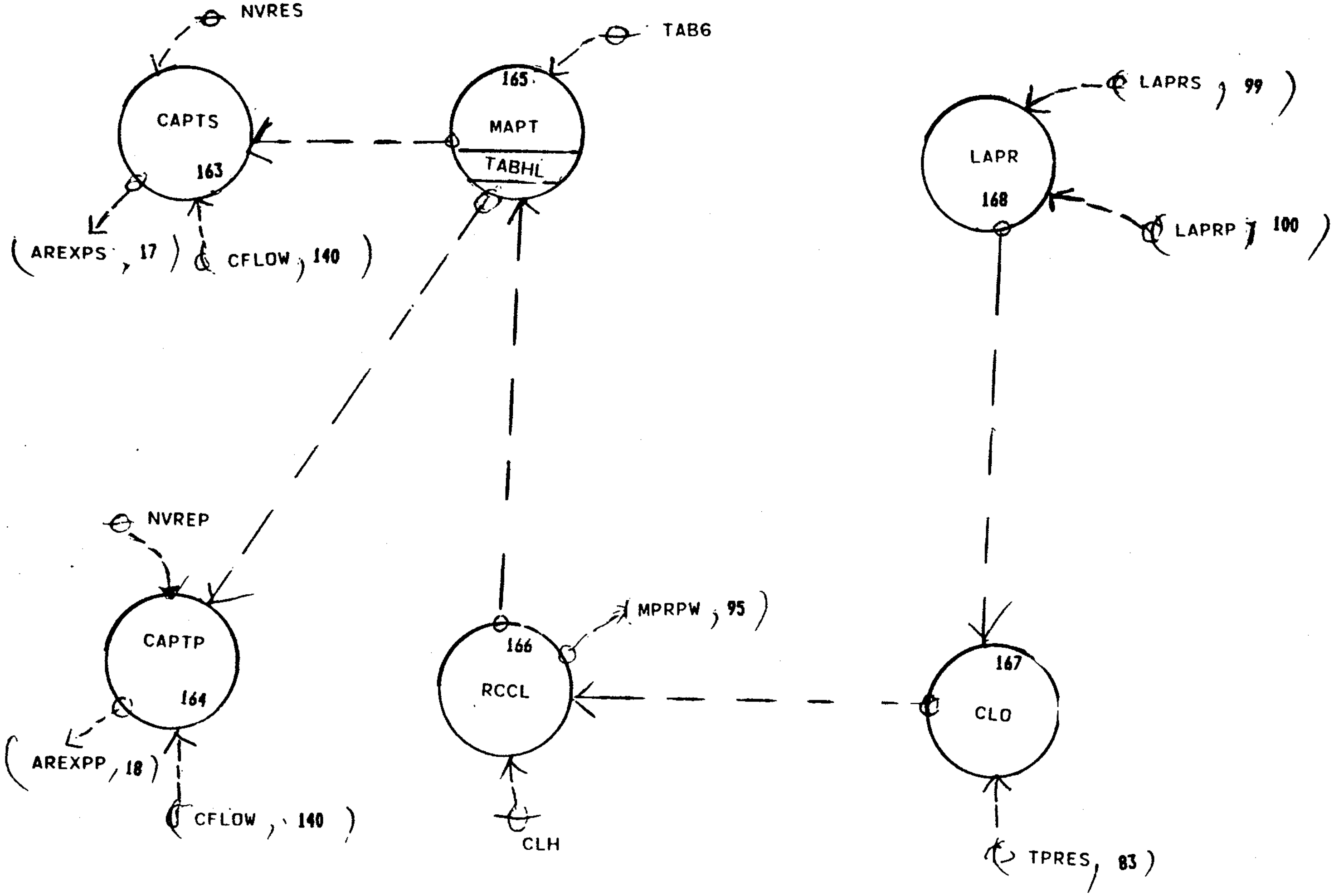
(Depreciation and depletion)



INVESTMENT FLOWS AND FINANCIAL PERFORMANCE SECTOR



EXPLORATION POLICY SECTOR



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APPENDIX B

A listing of the equations of the model in the DYNAMO system simulation language, together with the definitions of the names of variables used in the model.

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         *    SIMULATION MODEL OF AN OIL COMPANY                                  10.00001
         NOTE                                                                     10.00002
         NOTE ALL MONEY VALUES                                                    10.00003
         NOTE EXPRESSED IN CANADIAN CONSTANT DOLLARS                              10.00004
         NOTE                                                                     10.00005
         NOTE                                                                     10.00006
         NOTE ** LEASE SECTOR **                                                  10.00007
         NOTE                                                                     10.00008
         NOTE QUALITY OF GEOLOGICAL INFORMATION                                   10.00009
         NOTE                                                                     10.00011
  2      A ACPA.K=TABHL(TAB1,QCGI.K,1,4,1)                                        10.10020
         T      TAB1=5/7/10/14                                                    10.10021
  3      A      QCGI.K=SAMPLE(NORMRN(MQC,SQC),3,MQC)                              10.10030
         C      MQC=2.5                                                           10.10031
         C      SQC=0.6                                                           10.10032
         NOTE                                                                     10.10033
         NOTE DIVISION OF RAW LAND HOLDINGS                                       10.10034
         NOTE                                                                     10.10035
  4      A RLA.K=TABHL(TAB2,ACPA.K,6,14,2)*APB/12                                 10.10040
         C      APB=80                                                            10.10041
         T      TAB2=15/20/40/35/30                                               10.10042
  5      R      RALA.KL=RLA.K+MAX(DRHOL.K-RLHOL.K,O)/MEXP                         10.10050
         N      RALA=RLA                                                          10.10051
  6      L      RLHOL.K=RLHOL.J+DT*(RALA.JK-RULDS.JK-RULDP.JK-RULFO.JK-RLEXP.JK)  10.10060
         N      RLHOL=BRLHOL                                                      10.10061
         C      BRLHOL=3000                                                       10.10062
  7      R      RULDS.KL=AREXPS.JK*SPW                                            10.10070
  8      R      RULDP.KL=AREXPP.JK*SPW                                            10.10080
         C      SPW=40                                                            10.10081
         C      MEXP=60                                                           10.10082
  9      A      RULFON.K=ARALA.K*PFO                                              10.10090
         C      PFO=0.05                                                          10.10091
 10      R      RULFO.KL=RULFON.K+MIN(MFO*RLHOL.K,MAX(RLHOL.K-DRHOL.K,O))/MEXP    10.10100
         N      RULFO=RULFON                                                      10.10101
         C      MFO=.1                                                            10.10102
 11      A      ANRULD.K=SMOOTH(RULDS.JK+RULDP.JK+RULFON.K,TTARA)                 10.10110
         C      TTARA=12                                                          10.10111
 12      A      DRHOL.K=ANRULD.K*MEXP                                             10.10120
 13      A      ARALA.K=SMOOTH(RALA.JK,MEXP)                                      10.10130
 14      A      ARULD.K=SMOOTH(RULDS.JK+RULDP.JK+RULFO.JK,MEXP)                   10.10140
 15      R      RLEXP.KL=ARALA.K-ARULD.K                                          10.10150
         NOTE                                                                     10.10151
         NOTE EXPLORATION SECTOR                                                  10.10152
         NOTE                                                                     10.10153
         NOTE EXPLORATION RATES OF RAW LAND HOLDINGS                              10.10154
         NOTE                                                                     10.10155
 16      A EXPF.K=RULFO.JK/SPW                                                    10.10160
 17      R      AREXPS.KL=MIN(CAPTS.K/ECPEWS.K,RLHOL.K*PDS/SPW)                   10.10170
 18      R      AREXPP.KL=MIN(CAPTP.K/ECPEWP.K,RLHOL.K*PDP/SPW)                   10.10180
         N      PDS=0.5/12                                                        10.10181
         N      PDP=0.4/12                                                        10.10182
         NOTE                                                                     10.10183
         NOTE RATE OF DRILLING WILDCAT & DEVELOPMENT SOLELY BY COMPANY            10.10184
         NOTE                                                                     10.10185
 19      A WAREXS.K=WS*AREXPS.JK                                                  10.10190
 20      A      DAREXS.K=(1-WS)*AREXPS.JK                                         10.10200
         C      WS=0.7                                                            10.10201
 21      L      TWES.K=TWES.J+DT*(AREXPS.JK-RCWES.JK)                             10.10210
```

```
        N       TWES=3                                              10.10211
22      R       RCWES.KL=DELAY3(AREXPS.JK,DCE)                      10.10220
        C       DCE=18                                              10.10221
        NOTE                                                        10.10222
        NOTE UNDER PARTNERSHIP                                      10.10223
        NOTE                                                        10.10224
23      A WAREXP.K=WP*AREXPP.JK                                     10.10230
24      A       DAREXP.K=(1-WP)*AREXPP.JK                           10.10240
        C       WP=0.7                                              10.10241
        NOTE                                                        10.10242
        NOTE SUCCESS IN DRILLING EXPLORATORY WILDCAT WELLS:         10.10243
        NOTE SOLELY BY COMPANY                                      10.10244
        NOTE                                                        10.10245
25      R WRSEWS.KL=SAMPLE(NORMRN(WMSES.K,WSSES.K),1,WMSES.K)       10.10250
26      A       WMSES.K=WSRS*WAREXS.K                               10.10260
        C       WSRS=0.15                                           10.10261
27      A       WSSES.K=0.01*WAREXS.K                               10.10270
28      L       WTSEWS.K=WTSEWS.J+DT*WRSEWS.JK                      10.10280
        N       WTSEWS=BSEWS                                        10.10281
        C       BSEWS=2                                             10.10282
        NOTE                                                        10.10283
        NOTE UNDER PARTNERSHIP                                      10.10284
        NOTE                                                        10.10285
29      R WRSEWP.KL=SAMPLE(NORMRN(MSEP.K,SSEP.K),1,MSEP.K)          10.10290
30      A       MSEP.K=WSRP*WAREXP.K                                10.10300
        C       WSRP=0.15                                           10.10301
31      A       SSEP.K=0.01*WAREXP.K                                10.10310
32      L       WTSEWP.K=WTSEWP.J+DT*WRSEWP.JK                      10.10320
        N       WTSEWP=BSEWP                                        10.10321
        C       BSEWP=2                                             10.10322
        NOTE                                                        10.10323
        NOTE SUCCESS IN DRILLING DEVELOPMENT WELLS                  10.10324
        NOTE SOLELY BY COMPANY                                      10.10325
        NOTE                                                        10.10326
33      R DRSEWS.KL=SAMPLE(NORMRN(DMSES.K,DSSES.K),1,DMSES.K)       10.10330
34      A       DMSES.K=DSRS*DAREXS.K                               10.10340
        C       DSRS=0.8                                            10.10341
35      A       DSSES.K=0.05*DAREXS.K                               10.10350
36      L       DTSEWS.K=DTSEWS.J+DT*DRSEWS.JK                      10.10360
        N       DTSEWS=0                                            10.10361
37      R       TRSEWS.KL=WRSEWS.JK+DRSEWS.JK                       10.10370
38      L       TWSES.K=TWSES.J+DT*(TRSEWS.JK)                      10.10380
        N       TWSES=4                                             10.10381
        NOTE                                                        10.10382
        NOTE UNDER PARTNEWSHIP                                      10.10383
        NOTE                                                        10.10384
39      R DRSEWP.KL=SAMPLE(NORMRN(DMSEP.K,DSSEP.K),1,DMSEP.K)       10.10390
40      L       TWEP.K=TWEP.J+DT*(AREXPP.JK-RCWEP.JK)               10.10400
        N       TWEP=3                                              10.10401
41      R       RCWEP.KL=DELAY3(AREXPP.JK,DCE)                      10.10410
42      R       TRSEWP.KL=WRSEWP.JK+DRSEWP.JK                       10.10420
43      L       TWSEP.K=TWSEP.J+DT*(TRSEWP.JK)                      10.10430
        N       TWSEP=4                                             10.10431
44      A       DMSEP.K=DSRP*DAREXP.K                               10.10440
        C       DSRP=0.7                                            10.10441
45      A       DSSEP.K=0.05*DAREXP.K                               10.10450
46      L       DTSEWP.K=DTSEWP.J+DT*DRSEWP.JK                      10.10460
        N       DTSEWP=0                                            10.10461
```

```
        NOTE                                                            10.10462
        NOTE FARMED OUT                                                 10.10463
        NOTE                                                            10.10464
47      R RSEWF.KL=SAMPLE(NORMRN(MSEF.K,SSEF.K),1,MSEF.K)               10.10470
48      A      MSEF.K=WSRF*EXPF.K                                       10.10480
        C      WSRF=0.08                                                10.10481
49      A      SSEF.K=0.01*EXPF.K                                       10.10490
50      L      TWSEF.K=TWSEF.J+DT*RSEWF.JK                              10.10500
        N      TWSEF=BSEWF                                              10.10501
        C      BSEWF=0                                                  10.10502
        NOTE                                                            10.10503
        NOTE COMPLETION STAGE SECTOR                                    10.10504
        NOTE                                                            10.10505
51      A WRASCS.K=DLINF3(WRSEWS.JK,DECP)                               10.10510
52      A      WRASCP.K=DLINF3(WRSEWP.JK,DECP)                          10.10520
53      A      DRASCS.K=DLINF3(DRSEWS.JK,DECP)                          10.10530
54      A      DRASCP.K=DLINF3(DRSEWP.JK,DECP)                          10.10540
        C      DECP=12                                                  10.10541
55      R      RCWS.KL=DRASCS.K+WRASCS.K                                10.10550
56      R      RCWP.KL=DRASCP.K+WRASCP.K                                10.10560
57      R      RCWF.KL=DELAY3(RSEWF.JK,DECP)                            10.10570
58      R      RRCWF.KL=DELAY3(RCWF.JK,DEC)                             10.10580
59      R      RRCWS.KL=DELAY3(RCWS.JK,DEC)                             10.10590
60      L      TCWS.K=TCWS.J+DT*(RCWS.JK-RRCWS.JK)                      10.10600
        N      TCWS=2                                                   10.10601
        C      DEC=24                                                   10.10602
61      R      RRCWP.KL=DELAY3(RCWP.JK,DEC)                             10.10610
62      L      TCWP.K=TCWP.J+DT*(RCWP.JK-RRCWP.JK)                      10.10620
        N      TCWP=1                                                   10.10621
        NOTE                                                            10.10622
        NOTE PRODUCING WELLS SECTOR:                                    10.10623
        NOTE COMPLETED SOLELY BY COMPANY                                10.10624
        NOTE                                                            10.10625
63      L TPWS.K=TPWS.J+DT*(RRCWS.JK-RDPWS.JK)                          10.10630
        N      TPWS=4                                                   10.10631
64      R      RDPWS.KL=TPWS.K/AWLS.K                                   10.10640
65      A      AWLS.K=(URFS*TPRS.K)/STAPS.K                             10.10650
        C      URFS=0.8                                                 10.10651
        NOTE                                                            10.10652
        NOTE COMPLETED UNDER PARTNERSHIP                                10.10653
        NOTE                                                            10.10654
66      L TPWP.K=TPWP.J+DT*(RRCWP.JK-RDPWP.JK)                          10.10660
        N      TPWP=4                                                   10.10661
67      R      RDPWP.KL=TPWP.K/AWLP.K                                   10.10670
68      A      AWLP.K=(URFP*TPRP.K)/STAPP.K                             10.10680
        C      URFP=0.8                                                 10.10681
        NOTE                                                            10.10682
        NOTE COMPLETED UNDER FARM OUT                                   10.10683
        NOTE                                                            10.10684
69      L TPWF.K=TPWF.J+DT*(RRCWF.JK-RDPWF.JK)                          10.10690
        N      TPWF=2                                                   10.10691
70      R      RDPWF.KL=TPWF.K/AWLF.K                                   10.10700
71      A      AWLF.K=(URFF*TPRF.K)/STAPF.K                             10.10710
        C      URFF=0.8                                                 10.10711
        NOTE                                                            10.10712
        NOTE PROVEN WELLS SECTOR:                                       10.10713
        NOTE COMPLETED BY COMPANY                                       10.10714
        NOTE                                                            10.10715
```

```
72      L TPRS.K=TPRS.J+DT*(RPRS.JK-PRS.JK)                    10.10720
        N       TPRS=BTPRS                                     10.10721
        C       BTPRS=2.8E6                                    10.10722
73      R       RPRS.KL=APURS.K*RRCWS.JK                       10.10730
74      A       APURS.K=SAMPLE(SAPURS.K,12,4E5)                10.10740
75      A       SAPURS.K=NORMRN(MPRS.K,SPRS)                   10.10750
76      A       MPRS.K=TABHL(TAB7,QCGITLP.K,1,4,1)             10.10760
        T       TAB7=3E5/5E5/8E5/1E6                           10.10761
        C       SPRS=8E3                                       10.10762
77      A       QCGITLP.K=DELAY3(QCGI.K,42)                    10.10770
        NOTE                                                   10.10771
        NOTE COMPLETED UNDER PARTNERSHIP                       10.10772
        NOTE                                                   10.10773
78      L TPRP.K=TPRP.J+DT*(RPRP.JK-PRP.JK)                    10.10780
        N       TPRP=BTPRP                                     10.10781
        C       BTPRP=1.5E6                                    10.10782
79      R       RPRP.KL=APURP.K*RRCWP.JK                       10.10790
80      A       APURP.K=SAMPLE(SAPURP.K,12,5E5)                10.10800
81      A       SAPURP.K=NORMRN(MPRP.K,SPRP)                   10.10810
82      A       MPRP.K=TABHL(TAB8,QCGITLP.K,1,4,1)             10.10820
        T       TAB8=4E5/5E5/8E5/1E6                           10.10821
        C       SPRP=5E3                                       10.10822
83      A       TPRES.K=TPRS.K+(0.5*TPRP.K)                    10.10830
        NOTE                                                   10.10831
        NOTE COMPLETED UNDER FARM OUT                          10.10832
        NOTE                                                   10.10833
84      A APURF.K=SAMPLE(SAPURF.K,12,3E5)                      10.10840
85      A       SAPURF.K=NORMRN(MPRF,SPRF)                     10.10850
        C       MPRF=3E5                                       10.10851
86      L       TPRF.K=TPRF.J+DT*(RPRF.JK-PRF.JK)              10.10860
        N       TPRF=BTPRF                                     10.10861
        C       BTPRF=5E5                                      10.10862
87      R       RPRF.KL=APURF.K*RRCWF.JK                       10.10870
        C       SPRF=5E4                                       10.10871
        NOTE                                                   10.10872
        NOTE PRODUCTION CAPACITY SECTOR                        10.10873
        NOTE                                                   10.10874
        NOTE WELL COMPLETED SOLELY BY COMPANY                  10.10875
        NOTE                                                   10.10876
88      A       RCPS.K=RRCWS.JK*NPRPWS                         10.10880
        C       NPRPWS=3500                                    10.10881
        NOTE                                                   10.10882
        NOTE WELLS COMPLETED UNDER PARTNERSHIP                 10.10883
        NOTE                                                   10.10884
89      A       RCPP.K=RRCWP.JK*NPRPWP                         10.10890
        C       NPRPWP=3500                                    10.10891
        NOTE                                                   10.10892
        NOTE WELLS COMPLETED UNDER FARM OUT                    10.10893
        NOTE                                                   10.10894
90      A       RCPF.K=RRCWF.JK*NPRPWF                         10.10900
        C       NPRPWF=3000                                    10.10901
        NOTE                                                   10.10902
        NOTE PRODUCTION SECTOR                                 10.10903
        NOTE                                                   10.10904
91      R PRS.KL=TPWS.K*ALP.K*MPRPW.K                          10.10910
92      R       PRP.KL=TPWP.K*ALP.K*MPRPW.K                    10.10920
93      R       PRF.KL=TPWF.K*ALP.K*MPRPW.K                    10.10930
94      A       ALP.K=IALP+STEP(CIALP,120)                     10.10940
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```
         C      IALP=3.5E3                                              10.10941
         C      CIALP=0                                                 10.10942
 95      A      MPRPW.K=TABHL(TPRPW,RCCL.K,0.2,1.4,0.4)                 10.10950
         T      TPRPW=0.8/.9/1/1                                        10.10951
         NOTE                                                           10.10952
         NOTE SHORT & LONG TERM AVERAGE PORDUCTION RATES                10.10953
         NOTE                                                           10.10954
 96      L STAPS.K=STAPS.J+(DT/STAS)*(PRS.JK-STAPS.J)                   10.10960
         N      STAPS=TPWS*NPRPWS                                       10.10961
         C      STAS=6                                                  10.10962
 97      L      STAPP.K=STAPP.J+(DT/STAP)*(PRP.JK-STAPP.J)              10.10970
         N      STAPP=TPWP*NPRPWP                                       10.10971
         C      STAP=6                                                  10.10972
 98      L      STAPF.K=STAPF.J+(DT/STAF)*(PRF.JK-STAPF.J)              10.10980
         N      STAPF=TPWF*NPRPWF                                       10.10981
         C      STAF=6                                                  10.10982
 99      L      LAPRS.K=LAPRS.J+(DT/LTAS)*(PRS.JK-LAPRS.J)              10.10990
         C      LTAS=24                                                 10.10991
         N      LAPRS=STAPS                                             10.10992
100      L      LAPRP.K=LAPRP.J+(DT/LTAS)*(PRP.JK-LAPRP.J)              10.11000
         N      LAPRP=STAPP                                             10.11001
         NOTE                                                           10.11002
         NOTE ** FINANCIAL ACCOUNTING SECTOR **                         10.11003
         NOTE                                                           10.11004
         NOTE PRICE PER BARREL AND COST OF PRODUCTION ASSUMPTIONS       10.11005
         NOTE                                                           10.11006
101      L PPB.K=PPB.J+DT*(PCIF.JK*PB)                                  10.11010
         N      PPB=PB                                                  10.11011
         C      PB=18                                                   10.11012
102      R      PCIF.KL=PULSE(IPIF/DT,FP,IVL)                           10.11020
         C      IPIF=0.                                                 10.11021
         C      IVL=1000                                                10.11022
         C      FP=120                                                  10.11023
103      A      PCPB.K=SAMPLE(SPCPB.K,12,2)                             10.11030
104      L      SPCPB.K=SPCPB.J+DT*(CIF.JK*CPB)                         10.11040
         N      SPCPB=CPB                                               10.11041
         C      CPB=2                                                   10.11042
         NOTE                                                           10.11043
         NOTE EXPLORATION AND DEVELOPMENT COST:                         10.11044
         NOTE WELLS DRILLED SOLELY BY COMPANY                           10.11045
         NOTE                                                           10.11046
105      A ACEPWS.K=SAMPLE(SACES.K,12,3.5E5)                            10.11050
106      A      SACES.K=ECPEWS.K+DAEWS.K                                10.11060
107      A      DAEWS.K=3E4                                             10.11070
108      A      ECPEWS.K=SAMPLE(NORMRN(MECS.K,SECS),12,MECS.K)          10.11080
         C      SECS=1E4                                                10.11081
109      L      MECS.K=MECS.J+DT*(CIF.JK*CES)                           10.11090
         N      MECS=CES                                                10.11091
         C      CES=3E5                                                 10.11092
110      R      CIF.KL=PULSE(ICIF/DT,12,12)                             10.11100
         C      ICIF=0.                                                 10.11101
111      A      ACDPWS.K=SAMPLE(SADES.K,12,3E5)                         10.11110
112      A      SADES.K=NORMRN(1.5,0.1)*ACEPWS.K                        10.11120
         NOTE                                                           10.11121
         NOTE WELLS DRILLED UNDER PARTNERSHIP                           10.11122
         NOTE                                                           10.11123
113      A ACEPWP.K=SAMPLE(SACEP.K,12,5E5)                              10.11130
114      A      SACEP.K=ECPEWP.K+DAEWS.K                                10.11140
```

```
115   A      ECPEWP.K=SAMPLE(NORMRN(MECP.K,SECP),12,MECP.K)             10.11150
      C      SECP=3E4                                                    10.11151
116   L      MECP.K=MECP.J+DT*(CIF.JK*CEP)                              10.11160
      N      MECP=CEP                                                    10.11161
      C      CEP=5E5                                                     10.11162
117   A      ACDPWP.K=SAMPLE(SADEP.K,12,5E5)                            10.11170
118   A      SADEP.K=NORMRN(1.5,0.1)*ACEPWP.K                           10.11180
      NOTE                                                               10.11181
      NOTE OPERATING REVENUE                                             10.11182
      NOTE                                                               10.11183
119   A TSRS.K=PPB.K*STAPS.K                                             10.11190
120   A      TSRP.K=PPB.K*STAPP.K*0.5                                    10.11200
121   A      TSRF.K=FF*PPB.K*STAPF.K                                     10.11210
      C      FF=.12                                                      10.11211
122   L      TSALE.K=TSALE.J+DT*(RSALE.JK-CBSALE.JK)                    10.11220
      N      TSALE=0                                                     10.11221
123   R      CBSALE.KL=PULSE(TSALE.K/DT,12,12)                          10.11230
124   A      TSALER.K=SAMPLE(TSALE.K,12,4E6)                            10.11240
125   R      RSALE.KL=TSRS.K+TSRP.K+TSRF.K                              10.11250
      NOTE                                                               10.11251
      NOTE OPERATING EXPENSES                                            10.11252
      NOTE                                                               10.11253
126   R RCP.KL=PCPB.K*(STAPS.K+0.5*STAPP.K)                              10.11260
127   R      RCES.KL=ACEPWS.K*RCWES.JK                                   10.11270
128   R      RCEP.KL=ACEPWP.K*RCWEP.JK                                   10.11280
129   R      RCCS.KL=ACDPWS.K*RRCWS.JK                                   10.11290
130   R      RCCP.KL=ACDPWP.K*RRCWP.JK                                   10.11300
131   R      GAEXR.KL=FRSGA*RSALE.JK                                     10.11310
      C      FRSGA=0.05                                                  10.11311
132   L      TEXP.K=TEXP.J+DT*(RCP.JK+RCES.JK+RCCS.JK+0.5*(RCEP.JK+RCCP.JK)+  10.11320
      X      TRP.JK+DDFL.JK+RCL.JK+GAEXR.JK+RSPCPS.JK+0.5*RSPCPP.JK-CEXP.JK)  10.11321
      N      TEXP=0                                                      10.11322
133   A      TEXPR.K=SAMPLE(TEXP.K,12,3E6)                              10.11330
134   R      CEXP.KL=PULSE(TEXP.K/DT,12,12)                             10.11340
135   A      PBT.K=TSALER.K-TEXPR.K                                     10.11350
136   A      ATP.K=CLIP((1-TAX)*PBT.K,PBT.K,PBT.K,0)                    10.11360
      C      TAX=0.4                                                     10.11361
137   R      RCL.KL=RLHOL.K*SMOOTH(ACPA.K,12)                            10.11370
138   R      TRP.KL=RORP*RSALE.JK                                        10.11380
      C      RORP=0.15                                                   10.11381
      NOTE                                                               10.11382
      NOTE DEPRECIATION AND DEPLETION                                    10.11383
      NOTE                                                               10.11384
139   R DDFL.KL=DECFL.JK+DPCFL.JK                                        10.11390
140   A      CFLOW.K=ATP.K+TDFLR.K                                       10.11400
141   L      TDDFL.K=TDDFL.J+DT*(DECFL.JK+DPCFL.JK-CBDFL.JK)            10.11410
      N      TDDFL=0                                                     10.11411
142   A      TDFLR.K=SAMPLE(TDDFL.K,12,96E3)                            10.11420
143   R      CBDFL.KL=PULSE(TDDFL.K/DT,12,12)                           10.11430
144   R      DECFL.KL=DECFLS.JK+0.5*DECFLP.JK                            10.11440
145   R      DPCFL.KL=DPCFLS.JK+0.5*DPCFLP.JK                            10.11450
146   R      DECFLS.KL=CAPIPS.K/AWLS.K                                   10.11460
147   R      DECFLP.KL=CAPIPP.K/AWLP.K                                   10.11470
148   R      DPCFLS.KL=(DINVS.K/TPRS.K)*STAPS.K                          10.11480
149   R      DPCFLP.KL=(DINVP.K/TPRP.K)*STAPP.K                          10.11490
      NOTE                                                               10.11491
      NOTE ** INVESTMENT FLOWS AND FINANCIAL PERFORMANCE SECTOR **       10.11492
      NOTE                                                               10.11493
```

```
        NOTE RETURN ON INVESTMENT                                          10.11494
        NOTE                                                               10.11495
150     A ROI.K=(ATP.K*100)/TASSET.K                                       10.11500
        NOTE                                                               10.11501
        NOTE INVESTMENT IN DEVELOPMENT WELLS                               10.11502
        NOTE                                                               10.11503
151     L CAPIPS.K=CAPIPS.J+DT*(RSPCPS.JK-DECFLS.JK)                       10.11510
        N       CAPIPS=BCAPIS                                              10.11511
        C       BCAPIS=12E4                                                10.11512
152     R       RSPCPS.KL=RCPS.K*CAPCAP.K                                  10.11520
153     A       CAPCAP.K=SAMPLE(SCAP.K,12,20)                              10.11530
154     L       SCAP.K=SCAP.J+DT*(CIF.JK*ISCAP)                            10.11540
        N       SCAP=ISCAP                                                 10.11541
        C       ISCAP=20                                                   10.11542
155     L       CAPIPP.K=CAPIPP.J+DT*(RSPCPP.JK-DECFLP.JK)                 10.11550
        N       CAPIPP=BCAPIP                                              10.11551
        C       BCAPIP=12E4                                                10.11552
156     R       RSPCPP.KL=RCPP.K*CAPCAP.K                                  10.11560
157     L       DINVS.K=DINVS.J+DT*(RTCDS.JK-DPCFLS.JK)                    10.11570
        N       DINVS=3E5                                                  10.11571
158     L       DINVP.K=DINVP.J+DT*(RTCDP.JK-DPCFLP.JK)                    10.11580
        N       DINVP=3E5                                                  10.11581
159     R       RTCDS.KL=RRCWS.JK*ACDPWS.K                                 10.11590
160     R       RTCDP.KL=RRCWP.JK*ACDPWP.K                                 10.11600
        NOTE                                                               10.11601
        NOTE TOTAL ASSETS                                                  10.11602
        NOTE                                                               10.11603
161     L TASSET.K=TASSET.J+DT*(RAAST.JK-DDFL.JK)                          10.11610
        N       TASSET=5E6                                                 10.11611
162     R       RAAST.KL=RSPCPS.JK+0.5*RSPCPP.JK+RTCDS.JK+0.5*RTCDP.JK     10.11620
        NOTE                                                               10.11621
        NOTE ** EXPLORATION POLICY SECTOR **                               10.11622
        NOTE                                                               10.11623
163     A CAPTS.K=(MAX(CFLOW.K,0)*NVRES*MAPT.K)/12                         10.11630
164     A       CAPTP.K=(MAX(CFLOW.K,0)*NVREP*MAPT.K*2)/12                 10.11640
        C       NVRES=0.3                                                  10.11641
        C       NVREP=0.4                                                  10.11642
165     A       MAPT.K=TABHL(TAB6,RCCL.K,0.2,1.4,0.4)                      10.11650
        T       TAB6=1.4/1.2/1/0.6                                         10.11651
166     A       RCCL.K=CLO.K/CLH                                           10.11660
        C       CLH=240                                                    10.11661
167     A       CLO.K=TPRES.K/LAPR.K                                       10.11670
168     A       LAPR.K=LAPRS.K+(0.5*LAPRP.K)                               10.11680
        NOTE                                                               10.11681
        NOTE OUTPUT AND CONTROL SECTOR                                     10.11682
        NOTE                                                               10.11683
        PRINT  1)TWES,TWEP,TWSES,TWSEP,TWSEF,TCWS,TCWP                     10.11684
        PRINT  2)PPB,PCPB,DECFL,DPCFL                                      10.11685
        PRINT  3)STAPS,STAPP,STAPF,LAPRS,LAPRP,LAPR                        10.11686
        PRINT  4)PRS,PRP,PRF,MPRPW                                         10.11687
        PRINT  5)TPWS,TPWP,TPWF,AWLS,AWLP,AWLF                             10.11688
        PRINT  6)TPRS,TPRP,TPRF,TPRES                                      10.11689
        PRINT  7)WTSEWS,WTSEWP,DTSEWS,DTSEWP,RCCL                          10.11691
        PRINT  8)TASSET,PBT,CAPIPS,CAPIPP,DINVS,DINVP                      10.11692
        PRINT  9)TSALER,CFLOW,ATP,ROI,TEXPR,MAPT                           10.11693
        PRINT  10)RLHOL,RALA,RULDS,RULDP,RULFO,RULFON,RLEXP                10.11694
        PRINT  11)ARALA,ARULD,ANRULD,DRHOL                                 10.11695
        PRINT  12)AREXPS,AREXPP,EXPF,CAPTS,CAPTP                           10.11696
```

```
C LENGTH=480,DT=0.5,PRTPER=12,PLTPER=12,SAVPER=12                  10.11697
PLOT PPB=$(18,50)/TPRES=B/ATP=T                                    10.11698
X ROI=%/CFLOW=C/LAPR=P                                             10.11699
SAVE TPRES,ATP,ROI,CFLOW,LAPR                                      10.11701
PLOT RLA/RALA/TWES/WRSEWS/WRSEWP/TRSEWS/TRSEWP/RSEWF/TCWS/TCWP     10.11702
PLOT TPWS/TPWP/TPWF/TPRS/TPRP/TPRF                                 10.11703
PLOT PRS/PRP/PRF/LAPR                                              10.11704
PLOT RLHOL/AREXPS/AREXPP/EXPF/CAPTS/CAPTP                          10.11705
RUN RUNO      FREE RUNNING MODEL                                   10.11706
```

ALL MONEY VALUES
EXPRESSED IN CANADIAN CONSTANT DOLLARS
** LEASE SECTOR **
QUALITY OF GEOLOGICAL INFORMATION

```
ACPA.K=TABHL(TAB1,QCGI.K,1,4,1)                         2, A
TAB1=5/7/10/14                                          2.1, T
QCGI.K=SAMPLE(NORMRN(MQC,SQC),3,MQC)                    3, A
MQC=2.5                                                 3.1, C
SQC=0.6                                                 3.2, C
    ACPA    - ($/ACRE/M) AVE COST OF ACREAGE
    TAB1    - ($/ACRE/M) TABLE GIVING COST OF ACREAGE
    QCGI    - (1) QUALITY COEFFICIENT OF GEOLOGICAL
                INFORMATION
    MQC     - (1) MEAN QUALITY COEFFICIENT OF GEOLOGICAL
                INFORMATION
    SQC     - (1) STANDARD DEVIATION OF QUALITY
                COEFFICIENT OF GEOLOGICAL INFORMATION
```

DIVISION OF RAW LAND HOLDINGS

```
RLA.K=TABHL(TAB2,ACPA.K,6,14,2)*APB/12                4, A
APB=80                                                4.1, C
TAB2=15/20/40/35/30                                   4.2, T
RALA.KL=RLA.K+MAX(DRHOL.K-RLHOL.K,0)/MEXP             5, R
RALA=RLA                                              5.1, N
RLHOL.K=RLHOL.J+DT*(RALA.JK-RULDS.JK-RULDP.JK-        6, L
  RULFO.JK-RLEXP.JK)
RLHOL=BRLHOL                                          6.1, N
BRLHOL=3000                                           6.2, C
RULDS.KL=AREXPS.JK*SPW                                7, R
RULDP.KL=AREXPP.JK*SPW                                8, R
SPW=40                                                8.1, C
MEXP=60                                               8.2, C
RULFON.K=ARALA.K*PFO                                  9, A
PFO=0.05                                              9.1, C
RULFO.KL=RULFON.K+MIN(MFO*RLHOL.K,MAX(RLHOL.K-        10, R
  DRHOL.K,0))/MEXP
RULFO=RULFON                                          10.1, N
MFO=.1                                                10.2, C
ANRULD.K=SMOOTH(RULDS.JK+RULDP.JK+RULFON.K,TTARA)     11, A
TTARA=12                                              11.1, C
DRHOL.K=ANRULD.K*MEXP                                 12, A
ARALA.K=SMOOTH(RALA.JK,MEXP)                          13, A
ARULD.K=SMOOTH(RULDS.JK+RULDP.JK+RULFO.JK,MEXP)       14, A
RLEXP.KL=ARALA.K-ARULD.K                              15, R
    RLA     - (ACRES/M) RATE OF ACQUISITION OF ACREAGE
    TAB2    - (BLOCKS/Y) TABLE GIVING BLOCKS OF ACREAGE
                ACQUIRED PER YEAR
    ACPA    - ($/ACRE/M) AVE COST OF ACREAGE
    APB     - (ACRES/BLOCK) ACRES PER BLOCK OF ACREAGE
                ACQUIRED
    RALA    - (ACRES/M) RATE OF ACQUISITION OF ACREAGE
                PER MONTH
    DRHOL   - (ACRES) DESIRED AMOUNT OF RAW LAND HOLDINGS
    RLHOL   - (ACRES) AMOUNT OF RAW LAND HOLDINGS
    MEXP    - (M) EXPIRY TIME OF RAW LAND HOLDINGS
    RULDS   - (ACRES/M) RATE OF USAGE OF RAW LAND
                HOLDINGS FOR EXPLORATORY DRILLING
                (DRILLED SOLELY)
    RULDP   - (ACRES/M) RATE OF USAGE OF RAW LAND
                HOLDINGS FOR EXPLORATORY DRILLING(DRILLED
                UNDER PARTNERSHIP)
    RULFO   - (ACRES/M) RATE OF ACREAGE FARMED OUT
    RLEXP   - (ACRES/M) RATE OF EXPIRY OF RAW LAND
                HOLDINGS
    BRLHOL  - (ACRES) BASE VALUE OF RAW LAND HOLDINGS
    AREXPS  - (W/M) ACTUAL RATE OF EXPLORATORY
                DRILLING(SOLELY)
    SPW     - (ACRES/W) SPACING PER WELL
    AREXPP  - (W/M) ACTUAL RATE OF EXPLORATORY
                DRILLING(PARTNERSHIP)
    RULFON  - (ACRES/M) RATE OF ACREAGE NORMALLY FARMED
                OUT
    ARALA   - (ACRES/M) AV.RATE OF ACQUISITION OF ACREAGE
                OVER AV.TIME OF LEASES
    PFO     - (1) PROPORTION OF RAW LAND HOLDINGS FARMED
                OUT
    MFO     - (1) MAX FRACTION OF ACREAGE FARMED OUT
    ANRULD  - (ACRES/M) AVERAGE NORMAL RATE OF USAGE OF
                RAW LAND HOLDINGS
    TTARA   - (M) TIME TO AVERAGE RATE OF ACQUISITION OF
```

AV..TIME OF LEASES

EXPLORATION SECTOR
EXPLORATION RATES OF RAW LAND HOLDINGS

```
EXPF.K=RULFO.JK/SPW                                       16, A
AREXPS.KL=MIN(CAPTS.K/ECPEWS.K,RLHOL.K*PDS/SPW)           17, R
AREXPP.KL=MIN(CAPTP.K/ECPEWP.K,RLHOL.K*PDP/SPW)           18, R
PDS=0.5/12                                                18.1, N
PDP=0.4/12                                                18.2, N
    EXPF    - (W/M) RATE OF EXPLORATORY DRILLING OF
                FARMED OUT WELLS
    RULFO   - (ACRES/M) RATE OF ACREAGE FARMED OUT
    SPW     - (ACRES/W) SPACING PER WELL
    AREXPS  - (W/M) ACTUAL RATE OF EXPLORATORY
                DRILLING(SOLELY)
    CAPTS   - ($/M) CAPITAL AVAILABLE FOR EXPLORATORY
                DRILLING(SOLELY)
    ECPEWS  - ($/W) ESTIMATED COST OF EXPLORATION PER
                WELL TO BE DRILLED SOLELY
    RLHOL   - (ACRES) AMOUNT OF RAW LAND HOLDINGS
    PDS     - (1/M) PROPORTION OF RAW LAND HOLDINGS TO BE
                USED FOR SOLE DRILLING
    AREXPP  - (W/M) ACTUAL RATE OF EXPLORATORY
                DRILLING(PARTNERSHIP)
    CAPTP   - ($/M) CAPITAL AVAILABLE FOR EXPLORATORY
                DRILLING(PARTNERSHIP)
    ECPEWP  - ($/W) ESTIMATED COST OF EXPLORATION PER
                WELL TO BE DRILLED UNDER PARTNERSHIP
    PDP     - (1/M) PROPORTION OF RAW LAND HOLDINGS TO BE
                USED FOR DRILLING UNDER PARTNERSHIP
```

RATE OF DRILLING WILDCAT & DEVELOPMENT SOLELY BY
COMPANY

```
WAREXS.K=WS*AREXPS.JK                                     19, A
DAREXS.K=(1-WS)*AREXPS.JK                                 20, A
WS=0.7                                                    20.1, C
TWES.K=TWES.J+DT*(AREXPS.JK-RCWES.JK)                     21, L
TWES=3                                                    21.1, N
RCWES.KL=DELAY3(AREXPS.JK,DCE)                            22, R
DCE=18                                                    22.1, C
    WAREXS  - (W/M) RATE OF EXPLORATORY DRILLING (WILD
                CAT WELLS DRILLED SOLELY)
    WS      - (1) PROPORTION OF RATE OF EXPLORATORY
                DRILLING(DRILLED SOLELY)WHICH IS WILD CAT
                WELLS
    AREXPS  - (W/M) ACTUAL RATE OF EXPLORATORY
                DRILLING(SOLELY)
    DAREXS  - (W/M) RATE OF EXPLORATORY
                DRILLING(DEVELOPMENT WELLS DRILLED
                SOLELY)
    TWES    - (W) TOTAL WELLS IN EXPLORATION
                PROCESS(DRILLED SOLELY)
    RCWES   - (W/M) RATE OF COMPLETION OF EXPLORATORY
                DRILLING(WELLS DRILLED SOLELY
    DCE     - (M) DELAY IN COMPLETING THE EXPLORATION
```

UNDER PARTNERSHIP

```
WAREXP.K=WP*AREXPP.JK                                23, A
DAREXP.K=(1-WP)*AREXPP.JK                            24, A
WP=0.7                                               24.1, C
    WAREXP - (W/M) RATE OF EXPLORATORY DRILLING (WILD
               CAT WELLS DRILLED UNDER PARTNERSHIP)
    WP     - (1) PROPORTION OF RATE OF EXPLORATORY
               DRILLING WITH PARTNER WHICH ARE WILD CAT
               WELLS
    AREXPP - (W/M) ACTUAL RATE OF EXPLORATORY
               DRILLING(PARTNERSHIP)
    DAREXP - (W/M) RATE OF EXPLORATORY DRILLING(
               DEVELOPMENT WELLS DRILLRD UNDER
               PARTNERSHIP)
```

SUCCESS IN DRILLING EXPLORATORY WILDCAT WELLS:
SOLELY BY COMPANY

```
WRSEWS.KL=SAMPLE(NORMRN(WMSES.K,WSSES.K),1,WMSES.K) 25, R
WMSES.K=WSRS*WAREXS.K                                26, A
WSRS=0.15                                            26.1, C
WSSES.K=0.01*WAREXS.K                                27, A
WTSEWS.K=WTSEWS.J+DT*WRSEWS.JK                       28, L
WTSEWS=BSEWS                                         28.1, N
BSEWS=2                                              28.2, C
    WRSEWS - (W/M) RATE OF ADDITION OF SUCCESSFUL
               EXPLORATORY WILD CAT WELLS DRILLED SOLELY
    WMSES  - (W/M) MEAN VALUE OF RATE OF ADDITION OF
               SUCCESSFUL EXPLORATORY WILD CAT WELLS
               DRILLED SOLEY
    WSSES  - (W/M) STANDARD DEVIATION OF RATE OF
               ADDITION OF SUCCESSFUL EXPLORATORY WILD
               CAT WELLS DRILLED SOLEY
    WSRS   - (1) SUCCESS RATIO OF EXPLORATORY WILD CAT
               WELLS DRILLED SOLELY
    WAREXS - (W/M) RATE OF EXPLORATORY DRILLING (WILD
               CAT WELLS DRILLED SOLELY)
    WTSEWS - (W) CUMULATIVE NUMBER OF SUCCESSFUL
               EXPLORATORY WILD CAT WELLS DRILLED SOLELY
    BSEWS  - (W) BASE VALUE OF SUCCESSFUL EXPLORATORY
               WILD CAT WELLS DRILLED SOLELY
```

UNDER PARTNERSHIP

```
WRSEWP.KL=SAMPLE(NORMRN(MSEP.K,SSEP.K),1,MSEP.K)     29, R
MSEP.K=WSRP*WAREXP.K                                 30, A
WSRP=0.15                                            30.1, C
SSEP.K=0.01*WAREXP.K                                 31, A
WTSEWP.K=WTSEWP.J+DT*WRSEWP.JK                       32, L
WTSEWP=BSEWP                                         32.1, N
BSEWP=2                                              32.2, C
    WRSEWP - (W/M) RATE OF ADDITION OF SUCCESSFUL
               EXPLORATORY WILD CAT WELLS DRILLED UNDER
               PARTNERSHIP
    MSEP   - (W/M) MEAN VALUE OF RATE OF ADDITION OF
               SUCCESSFUL EXPLORATORY WILD CAT WELLS
               DRILLED UNDER PARTNERSHIP
    SSEP   - (W/M) STANDARD DEVIATION OF RATE OF
               ADDITION OF SUCCESSFUL EXPLORATORY WILD
               CAT WELLS DRILLED UNDER PARTNERSHIP
    WSRP   - (1) SUCCESS RATIO OF EXPLORATORY WILD CAT
               WELLS DRILLED UNDER PARTNERSHIP
    WAREXP - (W/M) RATE OF EXPLORATORY DRILLING (WILD
               CAT WELLS DRILLED UNDER PARTNERSHIP)
    WTSEWP - (W) CUMULATIVE NUMBER OF SUCCESSFUL
               EXPLORATORY WILD CAT WELLS DRILLED UNDER
               PARTNERSHIP
    BSEWP  - (W) BASE VALUE OF TOTAL NUMBER OF
               SUCCESSFUL EXPLORATORY WILD CAT WELLS
               DRILLED UNDER PARTNERSHIP
```

SUCCESS IN DRILLING DEVELOPMENT WELLS
SOLELY BY COMPANY

```
DRSEWS.KL=SAMPLE(NORMRN(DMSES.K,DSSES.K),1,DMSES.K) 33, R
DMSES.K=DSRS*DAREXS.K                               34, A
DSRS=0.8                                            34.1, C
DSSES.K=0.05*DAREXS.K                               35, A
DTSEWS.K=DTSEWS.J+DT*DRSEWS.JK                      36, L
DTSEWS=0                                            36.1, N
TRSEWS.KL=WRSEWS.JK+DRSEWS.JK                       37, R
TWSES.K=TWSES.J+DT*(TRSEWS.JK)                      38, L
TWSES=4                                             38.1, N
    DRSEWS - (W/M) RATE OF ADDITION OF SUCCESSFUL
               EXPLORATORY "DEVELOPMENT" WELLS DRILLED
               SOLELY
    DMSES  - (W/M) MEAN VALUE OF RATE OF ADDITION OF
               SUCCESSFUL EXPLORATORY DEVELOPMENT WELLS
               DRILLED SOLELY
    DSSES  - (W/M) STANDARD DEVIATION OF RATE OF
               ADDITION OF SUCCESSFUL EXPLORATORY "
               DEVELOPMENT" WELLS DRILLED SOLELY DT (M)
               SOLUTION INTERVAL
    DSRS   - (1) SUCCESS RATIO OF EXPLORATORY "
               DEVELOPMENT" WELLS DRILLED SOLELY
    DAREXS - (W/M) RATE OF EXPLORATORY
               DRILLING(DEVELOPMENT WELLS DRILLED
               SOLELY)
    DTSEWS - (W) CUMULATIVE NUMBER OF SUCCESSFUL
               EXPLORATORY "DEVELOPMENT" WELLS DRILLED
               SOLELY
    TRSEWS - (W/M) RATE OF ADDITION OF SUCCESSFUL
               EXPLORATORY WELLS DRILLED SOLELY
    WRSEWS - (W/M) RATE OF ADDITION OF SUCCESSFUL
               EXPLORATORY WILD CAT WELLS DRILLED SOLELY
    TWSES  - (W) CUMULATIVE NUMBER OF SUCCESSFUL
               EXPLORATORY WELLS DRILLED SOLELY
```

```
 UNDER PARTNEWSHIP

DRSEWP.KL=SAMPLE(NORMRN(DMSEP.K,DSSEP.K),1,DMSEP.K) 39, R
TWEP.K=TWEP.J+DT*(AREXPP.JK-RCWEP.JK)               40, L
TWEP=3                                              40.1, N
RCWEP.KL=DELAY3(AREXPP.JK,DCE)                      41, R
TRSEWP.KL=WRSEWP.JK+DRSEWP.JK                       42, R
TWSEP.K=TWSEP.J+DT*(TRSEWP.JK)                      43, L
TWSEP=4                                             43.1, N
DMSEP.K=DSRP*DAREXP.K                               44, A
DSRP=0.7                                            44.1, C
DSSEP.K=0.05*DAREXP.K                               45, A
DTSEWP.K=DTSEWP.J+DT*DRSEWP.JK                      46, L
DTSEWP=0                                            46.1, N
    DRSEWP - (W/M) RATE OF ADDITION OF SUCCESSFUL
               EXPLORATORY "DEVELOPMENT" WELLS DRILLED
               UNDER PARTNERSHIP
    DMSEP  - (W/M) MEAN VALUE OF RATE OF ADDITION OF
               SUCCESSFUL EXPLORATORY DEVELOPMENT WELLS
               DRILLED UNDER PARTNERSHIP
    DSSEP  - (W/M) STANDARD DEVIATION OF RATE OF
               ADDITION OF SUCCESSFUL EXPLORATORY "
               DEVELOPMENT" WELLS DRILLED UNDER
               PARTNERSHIP
    TWEP   - (W) TOTAL WELLS IN EXPLORATION
               PROCESS(DRILLED UNDER PARTNERSHIP)
    AREXPP - (W/M) ACTUAL RATE OF EXPLORATORY
               DRILLING(PARTNERSHIP)
    RCWEP  - (W/M) RATE OF COMPLETION OF EXPLORATORY
               DRILLING(WELLS DRILLED UNDER PARTNERSHIP
    DCE    - (M) DELAY IN COMPLETING THE EXPLORATION
    TRSEWP - (W/M) RATE OF ADDITION OF SUCCESSFUL
               EXPLORATORY WELLS DRILLED UNDER
               PARTNERSHIP
    WRSEWP - (W/M) RATE OF ADDITION OF SUCCESSFUL
               EXPLORATORY WILD CAT WELLS DRILLED UNDER
               PARTNERSHIP
    TWSEP  - (W) CUMULATIVE NUMBER OF SUCCESSFUL
               EXPLORATORY WELLS DRILLED UNDER
               PARTNERSHIP
    DSRP   - (1) SUCCESS RATIO OF EXPLORATORY "
               DEVELOPMENT" WELLS DRILLED UNDER
               PARTNERSHIP
    DAREXP - (W/M) RATE OF EXPLORATORY DRILLING(
               DEVELOPMENT WELLS DRILLRD UNDER
               PARTNERSHIP)
    DTSEWP - (W) CUMULATIVE NUMBER OF SUCCESSFUL
               EXPLORATORY "DEVELOPMENT" WELLS DRILLED
               UNDER PARTNERSHIP
```

FARMED OUT

```
RSEWF.KL=SAMPLE(NORMRN(MSEF.K,SSEF.K),1,MSEF.K)      47, R
MSEF.K=WSRF*EXPF.K                                   48, A
WSRF=0.08                                            48.1, C
SSEF.K=0.01*EXPF.K                                   49, A
TWSEF.K=TWSEF.J+DT*RSEWF.JK                          50, L
TWSEF=BSEWF                                          50.1, N
BSEWF=0                                              50.2, C
    RSEWF   - (W/M) RATE OF ADDITION OF SUCCESSFUL
                EXPLORATORY FARMED OUT WELLS
    MSEF    - (W/M) MEAN VALUE OF RATE OF ADDITION OF
                SUCCESSFUL EXPLORATORY FARMED OUT WELLS
    SSEF    - (W/M) STANDARD DEVIATION OF RATE OF
                ADDITION OF SUCCESSFUL EXPLORATORY FARMED
                OUT WELLS DRILLED
    WSRF    - (1) SUCCESS RATIO OF EXPLORATORY FARMED OUT
                WELLS
    EXPF    - (W/M) RATE OF EXPLORATORY DRILLING OF
                FARMED OUT WELLS
    TWSEF   - (W) CUMULATIVE NUMBER OF SUCCESSFUL
                EXPLORATORY FARMED OUT WELLS
    BSEWF   - (W) BASE VALUE OF CUMULATIVE NUMBER OF
                FARMED OUT WELLS DRILLED SOLELY
```

COMPLETION STAGE SECTOR

```
WRASCS.K=DLINF3(WRSEWS.JK,DECP)                    51, A
WRASCP.K=DLINF3(WRSEWP.JK,DECP)                    52, A
DRASCS.K=DLINF3(DRSEWS.JK,DECP)                    53, A
DRASCP.K=DLINF3(DRSEWP.JK,DECP)                    54, A
DECP=12                                            54.1, C
RCWS.KL=DRASCS.K+WRASCS.K                          55, R
RCWP.KL=DRASCP.K+WRASCP.K                          56, R
RCWF.KL=DELAY3(RSEWF.JK,DECP)                      57, R
RRCWF.KL=DELAY3(RCWF.JK,DEC)                       58, R
RRCWS.KL=DELAY3(RCWS.JK,DEC)                       59, R
TCWS.K=TCWS.J+DT*(RCWS.JK-RRCWS.JK)                60, L
TCWS=2                                             60.1, N
DEC=24                                             60.2, C
RRCWP.KL=DELAY3(RCWP.JK,DEC)                       61, R
TCWP.K=TCWP.J+DT*(RCWP.JK-RRCWP.JK)                62, L
TCWP=1                                             62.1, N
    WRASCS - (W/M) START RATE OF COMPLETION OF
                 SUCCESSFUL EXPLORATORY WILD CAT WELLS
                 DRILLED SOLELY
    WRSEWS - (W/M) RATE OF ADDITION OF SUCCESSFUL
                 EXPLORATORY WILD CAT WELLS DRILLED SOLELY
    DECP   - (M) DELAY IN STARTING THE COMPLETION
                 PROCESS
    WRASCP - (W/M) START RATE OF COMPLETION OF
                 SUCCESSFUL EXPLORATORY WILD CAT WELLS
                 DRILLED UNDER PARTNERSHIP
    WRSEWP - (W/M) RATE OF ADDITION OF SUCCESSFUL
                 EXPLORATORY WILD CAT WELLS DRILLED UNDER
                 PARTNERSHIP
    DRASCS - (W/M) START RATE OF COMPLETION OF
                 SUCCESSFUL EXPLORATORY WELLS DRILLED
                 SOLELY
    DRSEWS - (W/M) RATE OF ADDITION OF SUCCESSFUL
                 EXPLORATORY "DEVELOPMENT" WELLS DRILLED
                 SOLELY
    DRASCP - (W/M) START RATE OF COMPLETION OF
                 SUCCESSFUL EXPLORATORY WELLS DRILLED
                 UNDER PARTNERSHIP
    DRSEWP - (W/M) RATE OF ADDITION OF SUCCESSFUL
                 EXPLORATORY "DEVELOPMENT" WELLS DRILLED
                 UNDER PARTNERSHIP
    RCWS   - (W/M) START RATE OF COMPLETION OF WELLS
                 DRILLED SOLELY
    RCWP   - (W/M) START RATE OF COMPLETION OF WELLS
                 DRILLED UNDER PARTNERDHIP
    RCWF   - (W/M) START RATE OF COMPLETION OF FARMED
                 OUT WELLS
    RSEWF  - (W/M) RATE OF ADDITION OF SUCCESSFUL
                 EXPLORATORY FARMED OUT WELLS
    RRCWF  - (W/M) RATE OF COMPLETION OF FARMED OUT
                 WELLS
    DEC    - (M) DELAY IN COMPLETING THE WELLS
    RRCWS  - (W/M) RATE OF COMPLETION OF WELLS DRILLED
                 SOLELY
    TCWS   - (W) TOTAL WELLS IN THE PROCESS OF
                 COMPLETION( DRILLED SOLELY)
    RRCWP  - (W/M) RATE OF COMPLETION OF WELLS DRILLED
                 UNDER PARTNERSHIP
    TCWP   - (W) TOTAL WELLS IN THE PROCESS OF
                 COMPLETION(DRILLED UNDER PARTNERSHIP)
```

PRODUCING WELLS SECTOR:
COMPLETED SOLELY BY COMPANY

```
TPWS.K=TPWS.J+DT*(RRCWS.JK-RDPWS.JK)                    63, L
TPWS=4                                                  63.1, N
RDPWS.KL=TPWS.K/AWLS.K                                  64, R
AWLS.K=(URFS*TPRS.K)/STAPS.K                            65, A
URFS=0.8                                                65.1, C
    TPWS   - (W) TOTAL PRODUCING WELLS(COMPLETED SOLELY)
    RRCWS  - (W/M) RATE OF COMPLETION OF WELLS DRILLED
               SOLELY
    RDPWS  - (W/M) RATE OF DECAY OF PRODUCING WELLS
               COMPLETED SOLELY
    AWLS   - (M) AVE WELL LIFE(OWN SOLELY)
    URFS   - (1) ULTIMATE RECOVERY FACTOR(WELLS DRILLED
               SOLELY)
    TPRS   - (B) TOTAL PROVEN RESERVES FROM WELLS
               COMPLETED SOLELY
    STAPS  - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
               FROM WELLS DRILLED SOLELY
```

COMPLETED UNDER PARTNERSHIP

```
TPWP.K=TPWP.J+DT*(RRCWP.JK-RDPWP.JK)                    66, L
TPWP=4                                                  66.1, N
RDPWP.KL=TPWP.K/AWLP.K                                  67, R
AWLP.K=(URFP*TPRP.K)/STAPP.K                            68, A
URFP=0.8                                                68.1, C
    TPWP   - (W) TOTAL PRODUCING WELLS(COMPLETED UNDER
               PARTNERSHIP)
    RRCWP  - (W/M) RATE OF COMPLETION OF WELLS DRILLED
               UNDER PARTNERSHIP
    RDPWP  - (W/M) RATE OF DECAY OF PRODUCING WELLS
               COMPLETED UNDER PARTNERSHIP
    AWLP   - (M) AVE WELL LIFE(SHARING)
    URFP   - (1) ULTIMATE RECOVERY FACTOR(WELLS DRILLED
               UNDER PARTNERSHIP)
    TPRP   - (B) TOTAL PROVEN RESERVES FROM WELLS
               COMPLETED UNDER PARTNERSHIP
    STAPP  - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
               FROM WELLS DRILLED UNDER PARTNERSHIP
```

COMPLETED UNDER FARM OUT

```
TPWF.K=TPWF.J+DT*(RRCWF.JK-RDPWF.JK)                    69, L
TPWF=2                                                  69.1, N
RDPWF.KL=TPWF.K/AWLF.K                                  70, R
AWLF.K=(URFF*TPRF.K)/STAPF.K                            71, A
URFF=0.8                                                71.1, C
    TPWF   - (W) TOTAL PRODUCING FARMED OUT WELLS
    RRCWF  - (W/M) RATE OF COMPLETION OF FARMED OUT
                WELLS
    RDPWF  - (W/M) RATE OF DECAY OF PRODUCING FARMED OUT
                WELLS
    AWLF   - (M) AVE WELL LIFE(FARMED OUT WELL)
    URFF   - (1) ULTIMATE RECOVERY FACTOR(FARMED OUT
                WELLS)
    TPRF   - (B) TOTAL PROVEN RESERVES FROM FARMED OUT
                WELLS
    STAPF  - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
                FROM FARMED OUT WELLS
```

PROVEN WELLS SECTOR:
COMPLETED BY COMPANY

```
TPRS.K=TPRS.J+DT*(RPRS.JK-PRS.JK)                       72, L
TPRS=BTPRS                                              72.1, N
BTPRS=2.8E6                                             72.2, C
RPRS.KL=APURS.K*RRCWS.JK                                73, R
APURS.K=SAMPLE(SAPURS.K,12,4E5)                         74, A
SAPURS.K=NORMRN(MPRS.K,SPRS)                            75, A
MPRS.K=TABHL(TAB7,QCGITLP.K,1,4,1)                      76, A
TAB7=3E5/5E5/8E5/1E6                                    76.1, T
SPRS=8E3                                                76.2, C
QCGITLP.K=DELAY3(QCGI.K,42)                             77, A
    TPRS   - (B) TOTAL PROVEN RESERVES FROM WELLS
                COMPLETED SOLELY
    RPRS   - (B/M) RATE OF ADDITION OF PROVEN RESERVES
                TO WELLS DRILLED SOLELY
    PRS    - (B/M) PRODUCTION RATE FROM WELLS COMPLETED
                SOLELY
    BTPRS  - (B) BASE VALUE OF TOTAL PROVEN RESERVES
                FROM WELLS DRILLED SOLELY
    APURS  - (B/W) AVE PROVEN RESERVES PER WELL(SOLELY)
    RRCWS  - (W/M) RATE OF COMPLETION OF WELLS DRILLED
                SOLELY
    SAPURS - (B/W) SAMPLE VALUE OF AVERAGE PROVEN
                RESERVES PER WELL DRILLED SOLELY
    MPRS   - (B/W) MEAN PROVEN RESERVES PER WELL DRILLED
                SOLELY
    SPRS   - (B/W) STANDARD DEVIATION OF AVERAGE PROVEN
                RESERVES PER WELL DRILLED SOLELY
    TAB7   - (B/W) TABLE GIVING AVERAGE PROVEN RESERVES
                PER WELL DRILLED SOLELY
    QCGITLP- (1) QUALITY COEFFICIENT OF GEOLOGICAL
                INFORMATION AT TIME OF LEASING
    QCGI   - (1) QUALITY COEFFICIENT OF GEOLOGICAL
                INFORMATION
```

COMPLETED UNDER PARTNERSHIP

```
TPRP.K=TPRP.J+DT*(RPRP.JK-PRP.JK)                       78, L
TPRP=BTPRP                                              78.1, N
BTPRP=1.5E6                                             78.2, C
RPRP.KL=APURP.K*RRCWP.JK                                79, R
APURP.K=SAMPLE(SAPURP.K,12,5E5)                         80, A
SAPURP.K=NORMRN(MPRP.K,SPRP)                            81, A
MPRP.K=TABHL(TAB8,QCGITLP.K,1,4,1)                      82, A
TAB8=4E5/5E5/8E5/1E6                                    82.1, T
SPRP=5E3                                                82.2, C
TPRES.K=TPRS.K+(0.5*TPRP.K)                             83, A
    TPRP    - (B) TOTAL PROVEN RESERVES FROM WELLS
                COMPLETED UNDER PARTNERSHIP
    RPRP    - (B/M) RATE OF ADDITION OF PROVEN RESERVES
                TO WELLS DRILLED UNDER PARTNERSHIP
    PRP     - (B/M) PRODUCTION RATE FROM WELLS COMPLETED
                UNDER PARTNERSHIP
    BTPRP   - (B) BASE VALUE  OF TOTAL PROVEN RESERVES
                FROM WELLS COMPLETED UNDER PARTNERSHIP
    APURP   - (B/W) AVE PROVEN RESERVES PER
                WELL(PARTNERSHIP)
    RRCWP   - (W/M) RATE OF COMPLETION OF WELLS DRILLED
                UNDER PARTNERSHIP
    SAPURP  - (B/W) SAMPLE VALUE OF AVERAGE PROVEN
                RESERVES PER WELL DRILLED UNDER
                PARTNERSHIP
    MPRP    - (B/W) MEAN PROVEN RESERVES PER WELL DRILLED
                UNDER PARTNERSHIP
    SPRP    - (B/W) STANDARD DEVIATION OF AVERAGE PROVEN
                RESERVES PER WELL DRILLED UNDER
                PARTNERSHIP
    TAB8    - (B/W) TABLE GIVING AVERAGE PROVEN RESERVES
                PER WELL DRILLED UNDER PARTNERSHIP
    QCGITLP- (1) QUALITY COEFFICIENT OF GEOLOGICAL
                INFORMATION AT TIME OF LEASING
    TPRES   - (B) TOTAL PROVEN RESERVES
    TPRS    - (B) TOTAL PROVEN RESERVES FROM WELLS
                COMPLETED SOLELY
```

COMPLETED UNDER FARM OUT

```
APURF.K=SAMPLE(SAPURF.K,12,3E5)                          84, A
SAPURF.K=NORMRN(MPRF,SPRF)                               85, A
MPRF=3E5                                                 85.1, C
TPRF.K=TPRF.J+DT*(RPRF.JK-PRF.JK)                        86, L
TPRF=BTPRF                                               86.1, N
BTPRF=5E5                                                86.2, C
RPRF.KL=APURF.K*RRCWF.JK                                 87, R
SPRF=5E4                                                 87.1, C
    APURF  - (B/W) AVE PROVEN RESERVES PER WELL(FARMED
               OUT)
    SAPURF - (B/W) SAMPLE VALUE OF AVERAGE PROVEN
               RESERVES PER FARMED OUT WELL
    MPRF   - (B/W) MEAN PROVEN RESERVES PER FARMED OUT
               WELL
    SPRF   - (B/W) STANDARD DEVIATION OF AVERAGE PROVEN
               RESERVES PER FARMED OUT WELL
    TPRF   - (B) TOTAL PROVEN RESERVES FROM FARMED OUT
               WELLS
    RPRF   - (B/M) RATE OF ADDITION OF PROVEN RESERVES
               TO FARMED OUT WELLS
    PRF    - (B/M) PRODUCTION RATE FROM FARMED OUT WELLS
    BTPRF  - (B) BASE VALUE OF TOTAL PROVEN RESERVES
               FROM FARMED OUT WELLS
    RRCWF  - (W/M) RATE OF COMPLETION OF FARMED OUT
               WELLS
```

PRODUCTION CAPACITY SECTOR
WELL COMPLETED SOLELY BY COMPANY

```
RCPS.K=RRCWS.JK*NPRPWS                                   88, A
NPRPWS=3500                                              88.1, C
    RCPS   - (B/M**2) RATE OF ADDITION OF PRODUCTION
               CAPACITY TO WELLS DRILLED SOLELY
    RRCWS  - (W/M) RATE OF COMPLETION OF WELLS DRILLED
               SOLELY
    NPRPWS - (B/W/M) NORMAL VALUE OF DESIRED PRODUCTION
               RATE PER WELL COMPLETED SOLELY
```

WELLS COMPLETED UNDER PARTNERSHIP

```
RCPP.K=RRCWP.JK*NPRPWP                                   89, A
NPRPWP=3500                                              89.1, C
    RCPP   - (B/M**2) RATE OF ADDITION OF PRODUCTION
               CAPACITY TO WELLS DRILLED UNDER
               PARTNERSHIP
    RRCWP  - (W/M) RATE OF COMPLETION OF WELLS DRILLED
               UNDER PARTNERSHIP
    NPRPWP - (B/W/M) NORMAL VALUE OF DESIRED PRODUCTION
               RATE PER WELL COMPLETED UNDER PARTNERSHIP
```

WELLS COMPLETED UNDER FARM OUT

```
RCPF.K=RRCWF.JK*NPRPWF                                 90, A
NPRPWF=3000                                            90.1, C
    RCPF   - (B/M**2) RATE OF ADDITION OF PRODUCTION
               CAPACITY TO FARMED OUT WELLS
    RRCWF  - (W/M) RATE OF COMPLETION OF FARMED OUT
               WELLS
```

PRODUCTION SECTOR

```
PRS.KL=TPWS.K*ALP.K*MPRPW.K                            91, R
PRP.KL=TPWP.K*ALP.K*MPRPW.K                            92, R
PRF.KL=TPWF.K*ALP.K*MPRPW.K                            93, R
ALP.K=IALP+STEP(CIALP,120)                             94, A
IALP=3.5E3                                             94.1, C
CIALP=0                                                94.2, C
MPRPW.K=TABHL(TPRPW,RCCL.K,0.2,1.4,0.4)                95, A
TPRPW=0.8/.9/1/1                                       95.1, T
    PRS    - (B/M) PRODUCTION RATE FROM WELLS COMPLETED
               SOLELY
    TPWS   - (W) TOTAL PRODUCING WELLS(COMPLETED SOLELY)
    ALP    - (B/M/W) MAX ALLOWABLE RATE OF PRODUCTION
    MPRPW  - (1) TABLE GIVING MULTIPLIER FOR RATE OF
               PRODUCTION CAPACITY ADDITION
    PRP    - (B/M) PRODUCTION RATE FROM WELLS COMPLETED
               UNDER PARTNERSHIP
    TPWP   - (W) TOTAL PRODUCING WELLS(COMPLETED UNDER
               PARTNERSHIP)
    PRF    - (B/M) PRODUCTION RATE FROM FARMED OUT WELLS
    TPWF   - (W) TOTAL PRODUCING FARMED OUT WELLS
    IALP   - (B/W/M) INITIAL VALUE OF ALLOWABLE RATE OF
               PRODUCTION
    TPRPW  - (1) TABLE GIVING MULTIPLIERS FOR DESIRED
               PRODUCTION RATE PER WELL PER MONTH
    RCCL   - (1) RATIO OF ACTUAL COMPANY'S LIFE TO
               COMPANY'S DESIRED LIFE HORIZO
```

SHORT & LONG TERM AVERAGE PORDUCTION RATES

```
STAPS.K=STAPS.J+(DT/STAS)*(PRS.JK-STAPS.J)          96, L
STAPS=TPWS*NPRPWS                                   96.1, N
STAS=6                                              96.2, C
STAPP.K=STAPP.J+(DT/STAP)*(PRP.JK-STAPP.J)          97, L
STAPP=TPWP*NPRPWP                                   97.1, N
STAP=6                                              97.2, C
STAPF.K=STAPF.J+(DT/STAF)*(PRF.JK-STAPF.J)          98, L
STAPF=TPWF*NPRPWF                                   98.1, N
STAF=6                                              98.2, C
LAPRS.K=LAPRS.J+(DT/LTAS)*(PRS.JK-LAPRS.J)          99, L
LTAS=24                                             99.1, C
LAPRS=STAPS                                         99.2, N
LAPRP.K=LAPRP.J+(DT/LTAS)*(PRP.JK-LAPRP.J)          100, L
LAPRP=STAPP                                         100.1, N
    STAPS  - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
               FROM WELLS DRILLED SOLELY
    STAS   - (M) SMOOTHING FACTOR OF SHORT TERM AVERAGE
               PRODUCTION RATE FOR WELLS DRILLED SOLELY
    PRS    - (B/M) PRODUCTION RATE FROM WELLS COMPLETED
               SOLELY
    TPWS   - (W) TOTAL PRODUCING WELLS(COMPLETED SOLELY)
    NPRPWS - (B/W/M) NORMAL VALUE OF DESIRED PRODUCTION
               RATE PER WELL COMPLETED SOLELY
    STAPP  - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
               FROM WELLS DRILLED UNDER PARTNERSHIP
    STAP   - (M) SMOOTHING FACTOR OF SHORT TERM AVERAGE
               PRODUCTION RATE FOR WELLS DRILLED UNDER
               PARTNERSHIP
    PRP    - (B/M) PRODUCTION RATE FROM WELLS COMPLETED
               UNDER PARTNERSHIP
    TPWP   - (W) TOTAL PRODUCING WELLS(COMPLETED UNDER
               PARTNERSHIP)
    NPRPWP - (B/W/M) NORMAL VALUE OF DESIRED PRODUCTION
               RATE PER WELL COMPLETED UNDER PARTNERSHIP
    STAPF  - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
               FROM FARMED OUT WELLS
    STAF   - (M) SMOOTHING FACTOR OF SHORT TERM AVERAGE
               PRODUCTION RATE FOR FARMED WELLS
    PRF    - (B/M) PRODUCTION RATE FROM FARMED OUT WELLS
    TPWF   - (W) TOTAL PRODUCING FARMED OUT WELLS
    LAPRS  - (B/M) LONG TERM AVERAGE PRODUCTION RATE
               FROM WELLS COMPLETED SOLELY
    LTAS   - (M) LONG TERM PRODUCTION AVERAGING TIME
    LAPRP  - (B/M) LONG TERM AVERAGE PRODUCTION RATE
               FROM WELLS COMPLETED UNDER PARTNERSHIP
```

** FINANCIAL ACCOUNTING SECTOR **
PRICE PER BARREL AND COST OF PRODUCTION
ASSUMPTIONS

```
PPB.K=PPB.J+DT*(PCIF.JK*PB)                    101, L
PPB=PB                                         101.1, N
PB=18                                          101.2, C
PCIF.KL=PULSE(IPIF/DT,FP,IVL)                  102, R
IPIF=0.                                        102.1, C
IVL=1000                                       102.2, C
FP=120                                         102.3, C
PCPB.K=SAMPLE(SPCPB.K,12,2)                    103, A
SPCPB.K=SPCPB.J+DT*(CIF.JK*CPB)                104, L
SPCPB=CPB                                      104.1, N
CPB=2                                          104.2, C
    PPB    - ($/B) PRICE PER BARREL
    PCIF   - (1) RATIO REFLECTING RATE OF PRICE INCREASE
    PB     - ($/B) BASE VALUE OF PRICE PER BARREL
    IPIF   - (1) PRICE INFLATION FACTOR
    PCPB   - ($/B) PRODUCTION COST PER BARREL
    SPCPB  - ($/B) COST OF PRODUCTION PER BARREL
    CIF    - (1) COST INFLATION FACTOR
    CPB    - ($/B) INITIAL PRODUCTION COST PER BARREL AT
               THE END OF THE YEAR
```

EXPLORATION AND DEVELOPMENT COST:
WELLS DRILLED SOLELY BY COMPANY

```
ACEPWS.K=SAMPLE(SACES.K,12,3.5E5)                          105, A
SACES.K=ECPEWS.K+DAEWS.K                                   106, A
DAEWS.K=3E4                                                107, A
ECPEWS.K=SAMPLE(NORMRN(MECS.K,SECS),12,MECS.K)             108, A
SECS=1E4                                                   108.1, C
MECS.K=MECS.J+DT*(CIF.JK*CES)                              109, L
MECS=CES                                                   109.1, N
CES=3E5                                                    109.2, C
CIF.KL=PULSE(ICIF/DT,12,12)                                110, R
ICIF=0.                                                    110.1, C
ACDPWS.K=SAMPLE(SADES.K,12,3E5)                            111, A
SADES.K=NORMRN(1.5,0.1)*ACEPWS.K                           112, A
    ACEPWS - ($/W) AVE COST OF EXPLORATION PER
               WELL(SHARING)
    SACES  - ($/W) SAMPLE VALUE OF ACERAGE COST OF
               EXPLORATION PER WELL DRILLED SOLELY
    ECPEWS - ($/W) ESTIMATED COST OF EXPLORATION PER
               WELL TO BE DRILLED SOLELY
    DAEWS  - ($/W) DEVIATION OF ACTUAL COST OF
               EXPLORATION PER WELL FROM ESTIMATED COST
               OF EXPLORATION PER WELL
    MECS   - ($/W) MEAN VALUE OF ESTIMATED COST OF
               EXPLORATION PER WELL DRILLED SOLELY
    SECS   - ($/W) STANDARD DEVIATION OF ESTIMATED COST
               OF EXPLORATION PER WELL DRILLED SOLELY
    CIF    - (1) COST INFLATION FACTOR
    CES    - ($/W) BASE VALUE OF COST OF EXPLORATION PER
               WELL SOLELY
    ICIF   - (1) COST INFLATION FACTOR
    ACDPWS - ($/W) AVE COST OF DEVELOPMENT PER
               WELL(DRILLED SOLELY)
    SADES  - ($/W) SAMPLE VALUE OF AVERAGE COST OF
               DEVELOPMENT PER WELL DRILLED SOLELY
```

WELLS DRILLED UNDER PARTNERSHIP

```
ACEPWP.K=SAMPLE(SACEP.K,12,5E5)                      113, A
SACEP.K=ECPEWP.K+DAEWS.K                             114, A
ECPEWP.K=SAMPLE(NORMRN(MECP.K,SECP),12,MECP.K)       115, A
SECP=3E4                                             115.1, C
MECP.K=MECP.J+DT*(CIF.JK*CEP)                        116, L
MECP=CEP                                             116.1, N
CEP=5E5                                              116.2, C
ACDPWP.K=SAMPLE(SADEP.K,12,5E5)                      117, A
SADEP.K=NORMRN(1.5,O.1)*ACEPWP.K                     118, A
    ACEPWP - ($/W) AVE COST OF EXPLORATION PER
               WELL(SOLELY)
    SACEP  - ($/W) SAMPLE VALUE OF AVERAGE COST OF
               EXPLORATION PER WELL DRILLED UNDER
               PARTNERSHIP
    ECPEWP - ($/W) ESTIMATED COST OF EXPLORATION PER
               WELL TO BE DRILLED UNDER PARTNERSHIP
    DAEWS  - ($/W) DEVIATION OF ACTUAL COST OF
               EXPLORATION PER WELL FROM ESTIMATED COST
               OF EXPLORATION PER WELL
    MECP   - ($/W) MEAN VALUE OF ESTIMATED COST OF
               EXPLORATION PER WELL DRILLED UNDER
               PARTNERSHIP
    SECP   - ($/W) STANDARD DEVIATION OF ESTIMATED COST
               OF EXPLORATION PER WELL DRILLED UNDER
               PARTNERSHIP
    CIF    - (1) COST INFLATION FACTOR
    CEP    - ($/W) BASE VALUE OF MEAN VALUE OF COST OF
               EXPLORATION PER WELL DRILLED UNDER
               PARTNERSHIP
    ACDPWP - ($/W) AVE COST OF DEVELOPMENT PER WELL(
               SHARING)
    SADEP  - ($/W) SAMPLE VALUE OF AVERAGE COST OF
               DEVELOPMENT PER WELL DRILLED UNDER
               PARTNERSHIP
```

OPERATING REVENUE

```
TSRS.K=PPB.K*STAPS.K                                      119, A
TSRP.K=PPB.K*STAPP.K*0.5                                  120, A
TSRF.K=FF*PPB.K*STAPF.K                                   121, A
FF=.12                                                    121.1, C
TSALE.K=TSALE.J+DT*(RSALE.JK-CBSALE.JK)                   122, L
TSALE=0                                                   122.1, N
CBSALE.KL=PULSE(TSALE.K/DT,12,12)                         123, R
TSALER.K=SAMPLE(TSALE.K,12,4E6)                           124, A
RSALE.KL=TSRS.K+TSRP.K+TSRF.K                             125, R
    TSRS   - ($/M) SALES REVENUE RECEIVED FROM WELLS
                DRILLED SOLELY
    PPB    - ($/B) PRICE PER BARREL
    STAPS  - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
                FROM WELLS DRILLED SOLELY
    TSRP   - ($/M) SALES REVENUE RECEIVED FROM WELLS
                DRILLED UNDER PARTNERSHIP
    STAPP  - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
                FROM WELLS DRILLED UNDER PARTNERSHIP
    TSRF   - ($/M) SALES REVENUE PROCEEDING TO THE
                COMPANY FROM FARMED OUT WELLS
    FF     - (1) PROPORTION OF SALES REVENUE FROM FARMED
                OUT WELLS
    STAPF  - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
                FROM FARMED OUT WELLS
    TSALE  - $) TOTAL SALES REVENUE
    RSALE  - ($/M) RATE OF SALES REVENUE RECEIVED PER
                MONTH
    CBSALE - ($/Y) CLOSING BALANCE FOR SALES REVENUE
    TSALER - ($/Y) TOTAL SALES REVENUE REPORTED
```

OPERATING EXPENSES

```
RCP.KL=PCPB.K*(STAPS.K+0.5*STAPP.K)                         126, R
RCES.KL=ACEPWS.K*RCWES.JK                                   127, R
RCEP.KL=ACEPWP.K*RCWEP.JK                                   128, R
RCCS.KL=ACDPWS.K*RRCWS.JK                                   129, R
RCCP.KL=ACDPWP.K*RRCWP.JK                                   130, R
GAEXR.KL=FRSGA*RSALE.JK                                     131, R
FRSGA=0.05                                                  131.1, C
TEXP.K=TEXP.J+DT*(RCP.JK+RCES.JK+RCCS.JK+0.5*               132, L
  (RCEP.JK+RCCP.JK)+TRP.JK+DDFL.JK+RCL.JK+GAEXR.JK+
  RSPCPS.JK+0.5*RSPCPP.JK-CEXP.JK)
TEXP=0                                                      132.2, N
TEXPR.K=SAMPLE(TEXP.K,12,3E6)                               133, A
CEXP.KL=PULSE(TEXP.K/DT,12,12)                              134, R
PBT.K=TSALER.K-TEXPR.K                                      135, A
ATP.K=CLIP((1-TAX)*PBT.K,PBT.K,PBT.K,0)                     136, A
TAX=0.4                                                     136.1, C
RCL.KL=RLHOL.K*SMOOTH(ACPA.K,12)                            137, R
TRP.KL=RORP*RSALE.JK                                        138, R
RORP=0.15                                                   138.1, C
    RCP    - ($/M) COST OF PRODUCTION PER MONTH
    PCPB   - ($/B) PRODUCTION COST PER BARREL
    STAPS  - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
                FROM WELLS DRILLED SOLELY
    STAPP  - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
                FROM WELLS DRILLED UNDER PARTNERSHIP
    RCES   - ($/M) COST OF EXPLORATION(WELLS DRILLED
                SOLELY)
    ACEPWS - ($/W) AVE COST OF EXPLORATION PER
                WELL(SHARING)
    RCWES  - (W/M) RATE OF COMPLETION OF EXPLORATORY
                DRILLING(WELLS DRILLED SOLELY
    RCEP   - ($/M) COST OF EXPLORATION(WELLS DRILLED
                UNDER PARTNERSHIP)
    ACEPWP - ($/W) AVE COST OF EXPLORATION PER
                WELL(SOLELY)
    RCWEP  - (W/M) RATE OF COMPLETION OF EXPLORATORY
                DRILLING(WELLS DRILLED UNDER PARTNERSHIP
    RCCS   - ($/M) COST OF COMPLETION(WELLS DRILLED
                SOLELY)
    ACDPWS - ($/W) AVE COST OF DEVELOPMENT PER
                WELL(DRILLED SOLELY)
    RRCWS  - (W/M) RATE OF COMPLETION OF WELLS DRILLED
                SOLELY
    RCCP   - ($/M) COST OF COMPLETION(WELLS DRILLED
                UNDER PARTNERSHIP)
    ACDPWP - ($/W) AVE COST OF DEVELOPMENT PER WELL(
                SHARING)
    RRCWP  - (W/M) RATE OF COMPLETION OF WELLS DRILLED
                UNDER PARTNERSHIP
    GAEXR  - ($/M) GENERAL AND ADMINISTRATION EXPENSES
                RATE
    FRSGA  - (1) FRACTION CHARGED TO GENERAL AND
                ADMINISTRATION EXPENSES
    RSALE  - ($/M) RATE OF SALES REVENUE RECEIVED PER
                MONTH
    TEXP   - ($) TOTAL EXPENDITURE
    TRP    - ($/M) ROYALTY PAYMENTS
    DDFL   - ($/M) DEPRECIATION AND DEPLETION CASH FLOW
                PER MONTH
    RCL    - ($/M) COST OF ACREAGE
    RSPCPS - ($/M**2) RATE OF ADDITION OF INVESTMENT TO
```

RSPCPP - (\$/M**2) RATE OF ADDITION OF INVESTMENT TO
PRODUCTION CAPACITY OF WELLS DRILLED
UNDER PARTNERSHIP

CEXP - (\$/Y) CLOSING BALANCE FOR EXPENDITURE

TEXPR - (\$/Y) TOTAL EXPENDITURE REPORTED

PBT - (\$/Y) PROFIT BEFORE TAX

TSALER - (\$/Y) TOTAL SALES REVENUE REPORTED

ATP - (\$/Y) AFTER TAX PROFIT

TAX - (1) TAX RATE

RLHOL - (ACRES) AMOUNT OF RAW LAND HOLDINGS

ACPA - (\$/ACRE/M) AVE COST OF ACREAGE

RORP - (1) RATE OF ROYALTY PAYMENTS

DEPRECIATION AND DEPLETION

```
DDFL.KL=DECFL.JK+DPCFL.JK                                 139, R
CFLOW.K=ATP.K+TDFLR.K                                     140, A
TDDFL.K=TDDFL.J+DT*(DECFL.JK+DPCFL.JK-CBDFL.JK)           141, L
TDDFL=0                                                   141.1, N
TDFLR.K=SAMPLE(TDDFL.K,12,96E3)                           142, A
CBDFL.KL=PULSE(TDDFL.K/DT,12,12)                          143, R
DECFL.KL=DECFLS.JK+0.5*DECFLP.JK                          144, R
DPCFL.KL=DPCFLS.JK+0.5*DPCFLP.JK                          145, R
DECFLS.KL=CAPIPS.K/AWLS.K                                 146, R
DECFLP.KL=CAPIPP.K/AWLP.K                                 147, R
DPCFLS.KL=(DINVS.K/TPRS.K)*STAPS.K                        148, R
DPCFLP.KL=(DINVP.K/TPRP.K)*STAPP.K                        149, R
    DDFL   - ($/M) DEPRECIATION AND DEPLETION CASH FLOW
               PER MONTH
    DECFL  - ($/M) DEPRECIATION CASH FLOW
    DPCFL  - ($/M) DEPLETION CASH FLOW PER MONTH
    CFLOW  - ($/Y) CASH FLOW
    ATP    - ($/Y) AFTER TAX PROFIT
    TDFLR  - ($/Y) DEPRECIATION AND DEPLETION CASH FLOW
               REPORTED
    TDDFL  - ($) TOTAL DEPRECIATION AND DEPLETION CASH
               FLOW
    CBDFL  - ($/Y) CLOSING BALANCE FOR DEPRECIATION AND
               DEPLETION CASH FLOW
    DECFLS - ($/M) DEPRECIATION CASH FLOW FROM WELLS
               DRILLED SOLELY
    DECFLP - $/M) DEPRECIATION CASH FLOW FROM WELLS
               DRILLED UNDER PARTNERSHIP
    DPCFLS - ($/M) DEPLETION CASH FLOW PER MONTH FROM
               WELLS DRILLED SOLELY TO WELLS DRILLED
               SOLELY
    DPCFLP - ($/M) DEPLETION CASH FLOW PER MONTH FROM
               WELLS DRILLED UNDER PARTNERSHIP
    CAPIPS - ($) CAPITAL INVESTMNT ON PRODUCTION
               CAPACITY FROM WELLS DRILLED SOLELY
    AWLS   - (M) AVE WELL LIFE(OWN SOLELY)
    CAPIPP - ($) CAPITAL INVESTMENT ON PRODUCTION
               CAPACITY FROM WELLS DRILLED UNDER
               PARTNERSHIP
    AWLP   - (M) AVE WELL LIFE(SHARING)
    DINVS  - ($) CAPITAL INVESTMENT ON DEVELOPING THE
               WELLS DRILLED SOLELY
    TPRS   - (B) TOTAL PROVEN RESERVES FROM WELLS
               COMPLETED SOLELY
    STAPS  - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
               FROM WELLS DRILLED SOLELY
    DINVP  - ($) CAPITAL INVESTMENT ON DEVELOPING THE
               WELLS DRILLED UNDER PARTNERSHIP
    TPRP   - (B) TOTAL PROVEN RESERVES FROM WELLS
               COMPLETED UNDER PARTNERSHIP
    STAPP  - (B/M) SHORT TERM AVERAGE PRODUCTION RATE
               FROM WELLS DRILLED UNDER PARTNERSHIP
```

** INVESTMENT FLOWS AND FINANCIAL PERFORMANCE
SECTOR **
RETURN ON INVESTMENT

```
ROI.K=(ATP.K*100)/TASSET.K                              150, A
    ROI    - (%/Y) RETURN ON INVESTMENT
    ATP    - ($/Y) AFTER TAX PROFIT
    TASSET - ($) TOTAL ASSETS
```

INVESTMENT IN DEVELOPMENT WELLS

```
CAPIPS.K=CAPIPS.J+DT*(RSPCPS.JK-DECFLS.JK)          151, L
CAPIPS=BCAPIS                                       151.1, N
BCAPIS=12E4                                         151.2, C
RSPCPS.KL=RCPS.K*CAPCAP.K                           152, R
CAPCAP.K=SAMPLE(SCAP.K,12,20)                       153, A
SCAP.K=SCAP.J+DT*(CIF.JK*ISCAP)                     154, L
SCAP=ISCAP                                          154.1, N
ISCAP=20                                            154.2, C
CAPIPP.K=CAPIPP.J+DT*(RSPCPP.JK-DECFLP.JK)          155, L
CAPIPP=BCAPIP                                       155.1, N
BCAPIP=12E4                                         155.2, C
RSPCPP.KL=RCPP.K*CAPCAP.K                           156, R
DINVS.K=DINVS.J+DT*(RTCDS.JK-DPCFLS.JK)             157, L
DINVS=3E5                                           157.1, N
DINVP.K=DINVP.J+DT*(RTCDP.JK-DPCFLP.JK)             158, L
DINVP=3E5                                           158.1, N
RTCDS.KL=RRCWS.JK*ACDPWS.K                          159, R
RTCDP.KL=RRCWP.JK*ACDPWP.K                          160, R
    CAPIPS - ($) CAPITAL INVESTMNT ON PRODUCTION
               CAPACITY FROM WELLS DRILLED SOLELY
    RSPCPS - ($/M**2) RATE OF ADDITION OF INVESTMENT TO
               PRODUCTION CAPACITY OF WELLS DRILLED
               SOLELY
    DECFLS - ($/M) DEPRECIATION CASH FLOW FROM WELLS
               DRILLED SOLELY
    BCAPIS - ($) BASE VALUE OF CAPITAL INVESTMENT ON
               PRODUCTION CAPACITY FOR WELLS DRILLED
               SOLELY
    RCPS   - (B/M**2) RATE OF ADDITION OF PRODUCTION
               CAPACITY TO WELLS DRILLED SOLELY
    CAPCAP - ($/(B/M)) CAPITAL INVESTMENT ON PRODUCTION
               CAPACITY TO PRODUCE ONE BARREL OF OIL PER
               MONTH
    SCAP   - ($/(B/M)) SAMPLE VALUE OF CAPCAP
    CIF    - (1) COST INFLATION FACTOR
    ISCAP  - ($/B/M) COST OF ADDING PRODUCTION CAPACITY
               TO PRODUCE ONE BARREL OF OIL PER MONTH
    CAPIPP - ($) CAPITAL INVESTMENT ON PRODUCTION
               CAPACITY FROM WELLS DRILLED UNDER
               PARTNERSHIP
    RSPCPP - ($/M**2) RATE OF ADDITION OF INVESTMENT TO
               PRODUCTION CAPACITY OF WELLS DRILLED
               UNDER PARTNERSHIP
    DECFLP - $/M) DEPRECIATION CASH FLOW FROM WELLS
               DRILLED UNDER PARTNERSHIP
    BCAPIP - ($) BASE VALUE OF CAPITAL INVESTMENT ON
               PRODUCTION CAPACITY FOR WELLS DRILLED
               UNDER PARTNERSHIP
    RCPP   - (B/M**2) RATE OF ADDITION OF PRODUCTION
               CAPACITY TO WELLS DRILLED UNDER
               PARTNERSHIP
    DINVS  - ($) CAPITAL INVESTMENT ON DEVELOPING THE
               WELLS DRILLED SOLELY
    RTCDS  - ($/M) RATE OF ADDITION OF INVESTMENT ON
               DEVELOPMENT TO WELLS DRILLED SOLELY
    DPCFLS - ($/M) DEPLETION CASH FLOW PER MONTH FROM
               WELLS DRILLED SOLELY TO WELLS DRILLED
               SOLELY
    DINVP  - ($) CAPITAL INVESTMENT ON DEVELOPING THE
               WELLS DRILLED UNDER PARTNERSHIP
    RTCDP  - ($/M) RATE OF ADDITION OF INVESTMENT ON
```

DPCFLP - ($/M) DEPLETION CASH FLOW PER MONTH FROM WELLS DRILLED UNDER PARTNERSHIP

RRCWS - (W/M) RATE OF COMPLETION OF WELLS DRILLED SOLELY

ACDPWS - ($/W) AVE COST OF DEVELOPMENT PER WELL(DRILLED SOLELY)

RRCWP - (W/M) RATE OF COMPLETION OF WELLS DRILLED UNDER PARTNERSHIP

ACDPWP - ($/W) AVE COST OF DEVELOPMENT PER WELL(SHARING)

TOTAL ASSETS

```
TASSET.K=TASSET.J+DT*(RAAST.JK-DDFL.JK)               161, L
TASSET=5E6                                            161.1, N
RAAST.KL=RSPCPS.JK+0.5*RSPCPP.JK+RTCDS.JK+0.5*        162, R
  RTCDP.JK
    TASSET - ($) TOTAL ASSETS
    RAAST  - ($/M) RATE OF ADDITION OF ASSETS
    DDFL   - ($/M) DEPRECIATION AND DEPLETION CASH FLOW
               PER MONTH
    RSPCPS - ($/M**2) RATE OF ADDITION OF INVESTMENT TO
               PRODUCTION CAPACITY OF WELLS DRILLED
               SOLELY
    RSPCPP - ($/M**2) RATE OF ADDITION OF INVESTMENT TO
               PRODUCTION CAPACITY OF WELLS DRILLED
               UNDER PARTNERSHIP
    RTCDS  - ($/M) RATE OF ADDITION OF INVESTMENT ON
               DEVELOPMENT TO WELLS DRILLED SOLELY
    RTCDP  - ($/M) RATE OF ADDITION OF INVESTMENT ON
               DEVELOPMENT TO WELLS DRILLED UNDER
               PARTNERSHIP
```

** EXPLORATION POLICY SECTOR **

```
CAPTS.K=(MAX(CFLOW.K,O)*NVRES*MAPT.K)/12            163, A
CAPTP.K=(MAX(CFLOW.K,O)*NVREP*MAPT.K*2)/12          164, A
NVRES=0.3                                           164.1, C
NVREP=0.4                                           164.2, C
MAPT.K=TABHL(TAB6,RCCL.K,0.2,1.4,0.4)               165, A
TAB6=1.4/1.2/1/0.6                                  165.1, T
RCCL.K=CLO.K/CLH                                    166, A
CLH=240                                             166.1, C
CLO.K=TPRES.K/LAPR.K                                167, A
LAPR.K=LAPRS.K+(0.5*LAPRP.K)                        168, A
    CAPTS  - ($/M) CAPITAL AVAILABLE FOR EXPLORATORY
               DRILLING(SOLELY)
    CFLOW  - ($/Y) CASH FLOW
    NVRES  - (1) NORMAL VALUE FOR FRACTION OF CASH FLOW
               RETAINED FOR EXPLORATION SPENDING(DRILL
               SOLELY)
    MAPT   - (1) MULTIPLIER TO INCREASE EXPLORATION WHEN
               COMPANY"S LIFE RATIO FALLS
    CAPTP  - ($/M) CAPITAL AVAILABLE FOR EXPLORATORY
               DRILLING(PARTNERSHIP)
    NVREP  - (1) NORMAL VALUE FOR FRACTION OF CASH FLOW
               RETAINED FOR EXPLORATION(DRILL UNDER
               PARTNERSHIP)
    TAB6   - (1) TABLE GIVING MULTIPLIER FOR EXPLORATION
               SPENDING
    RCCL   - (1) RATIO OF ACTUAL COMPANY'S LIFE TO
               COMPANY'S DESIRED LIFE HORIZO
    CLO    - (M) COMPANY ACTUAL LIFE HORIZON
    CLH    - (M) COMPANY DESIRED LIFE HORIZON
    TPRES  - (B) TOTAL PROVEN RESERVES
    LAPR   - (B/M) LONG TERM AVERAGE PRODUCTION RATE
    LAPRS  - (B/M) LONG TERM AVERAGE PRODUCTION RATE
               FROM WELLS COMPLETED SOLELY
    LAPRP  - (B/M) LONG TERM AVERAGE PRODUCTION RATE
               FROM WELLS COMPLETED UNDER PARTNERSHIP
```

OUTPUT AND CONTROL SECTOR

```
LENGTH=480,DT=0.5,PRTPER=12,PLTPER=12,SAVPER=12     169.7, C
    LENGTH - (M) SIMULATED DURATION
    PRTPER - (M) PRINTING INTERVAL
```

APPENDIX C

Alphabetic listing of the names of variables in the model cross referencing by equation number where defined and where used.

NAME	NO	T	DEFINITION	WHERE USED
ACDPWP	117	A	($/W) AVE COST OF DEVELOPMENT PER WELL(SHARING)	RCCP,R,130/RTCDP,R,160
ACDPWS	111	A	($/W) AVE COST OF DEVELOPMENT PER WELL(DRILLED SOLELY)	RCCS,R,129/RTCDS,R,159
ACEPWP	113	A	($/W) AVE COST OF EXPLORATION PER WELL(SOLELY)	SADEP,A,118/RCEP,R,128
ACEPWS	105	A	($/W) AVE COST OF EXPLORATION PER WELL(SHARING)	SADES,A,112/RCES,R,127
ACPA	2	A	($/ACRE/M) AVE COST OF ACREAGE	RLA,A,4/RCL,R,137
ALP	94	A	(B/M/W) MAX ALLOWABLE RATE OF PRODUCTION	PRS,R,91/PRP,R,92/PRF,R,93
ANRULD	11	A	(ACRES/M) AVERAGE NORMAL RATE OF USAGE OF RAW LAND HOLDINGS	DRHOL,A,12
APB	4.1	C	(ACRES/BLOCK) ACRES PER BLOCK OF ACREAGE ACQUIRED	RLA,A,4
APURF	84	A	(B/W) AVE PROVEN RESERVES PER WELL(FARMED OUT)	RPRF,R,87
APURP	80	A	(B/W) AVE PROVEN RESERVES PER WELL(PARTNERSHIP)	RPRP,R,79
APURS	74	A	(B/W) AVE PROVEN RESERVES PER WELL(SOLELY)	RPRS,R,73
ARALA	13	A	(ACRES/M) AV.RATE OF ACQUISITION OF ACREAGE OVER AV.TIME OF LEASES	RULFON,A,9/RLEXP,R,15
AREXPP	18	R	(W/M) ACTUAL RATE OF EXPLORATORY DRILLING(PARTNERSHIP)	RULDP,R,8/WAREXP,A,23/DAREXP,A,24/TWEP,L,40/RCWEP,R,41
AREXPS	17	R	(W/M) ACTUAL RATE OF EXPLORATORY DRILLING(SOLELY)	RULDS,R,7/WAREXS,A,19/DAREXS,A,20/TWES,L,21/RCWES,R,22
ARULD	14	A	(ACRES/M) AV. RATE OF USAGE OF ACREAGEOVER AV. TIME OF LEASES	RLEXP,R,15
ATP	136	A	($/Y) AFTER TAX PROFIT	CFLOW,A,140/ROI,A,150
AWLF	71	A	(M) AVE WELL LIFE(FARMED OUT WELL)	RDPWF,R,70
AWLP	68	A	(M) AVE WELL LIFE(SHARING)	RDPWP,R,67/DECFLP,R,147
AWLS	65	A	(M) AVE WELL LIFE(OWN SOLELY)	RDPWS,R,64/DECFLS,R,146
BCAPIP	155.2	C	($) BASE VALUE OF CAPITAL INVESTMENT ON PRODUCTION CAPACITY FOR WELLS DRILLED UNDER PARTNERSHIP	CAPIPP,N,155.1
BCAPIS	151.2	C	($) BASE VALUE OF CAPITAL INVESTMENT ON PRODUCTION CAPACITY FOR WELLS DRILLED SOLELY	CAPIPS,N,151.1
BRLHOL	6.2	C	(ACRES) BASE VALUE OF RAW LAND HOLDINGS	RLHOL,N,6.1
BSEWF	50.2	C	(W) BASE VALUE OF CUMULATIVE NUMBER OF FARMED OUT WELLS DRILLED SOLELY	TWSEF,N,50.1
BSEWP	32.2	C	(W) BASE VALUE OF TOTAL NUMBER OF SUCCESSFUL EXPLORATORY WILD CAT WELLS DRILLED UNDER PARTNERSHIP	WTSEWP,N,32.1
BSEWS	28.2	C	(W) BASE VALUE OF SUCCESSFUL EXPLORATORY WILD CAT WELLS DRILLED SOLELY	WTSEWS,N,28.1
BTPRF	86.2	C	(B) BASE VALUE OF TOTAL PROVEN RESERVES FROM FARMED OUT WELLS	TPRF,N,86.1
BTPRP	78.2	C	(B) BASE VALUE OF TOTAL PROVEN RESERVES FROM WELLS COMPLETED UNDER PARTNERSHIP	TPRP,N,78.1
BTPRS	72.2	C	(B) BASE VALUE OF TOTAL PROVEN RESERVES FROM WELLS DRILLED SOLELY	TPRS,N,72.1
CAPCAP	153	A	($/(B/M)) CAPITAL INVESTMENT ON PRODUCTION CAPACITY TO PRODUCE ONE BARREL OF OIL PER MONTH	RSPCPS,R,152/RSPCPP,R,156

CAPIPP	155 155.1	L N	($) CAPITAL INVESTMENT ON PRODUCTION CAPACITY, FROM WELLS DRILLED UNDER PARTNERSHIP	DECFLP,R,147
CAPIPS	151 151.1	L N	($) CAPITAL INVESTMNT ON PRODUCTION CAPACITY FROM WELLS DRILLED SOLELY	DECFLS,R,146
CAPTP	164	A	($/M) CAPITAL AVAILABLE FOR EXPLORATORY DRILLING(PARTNERSHIP)	AREXPP,R,18
CAPTS	163	A	($/M) CAPITAL AVAILABLE FOR EXPLORATORY DRILLING(SOLELY)	AREXPS,R,17
CBDFL	143	R	($/Y) CLOSING BALANCE FOR DEPRECIATION AND DEPLETION CASH FLOW	TDDFL,L,141
CBSALE	123	R	($/Y) CLOSING BALANCE FOR SALES REVENUE	TSALE,L,122
CEP	116.2	C	($/W) BASE VALUE OF MEAN VALUE OF COST OF EXPLORATION PER WELL DRILLED UNDER PARTNERSHIP	MECP,L,116/MECP,N,116.1
CES	109.2	C	($/W) BASE VALUE OF COST OF EXPLORATION PER WELL SOLELY	MECS,L,109/MECS,N,109.1
CEXP	134	R	($/Y) CLOSING BALANCE FOR EXPENDITURE	TEXP,L,132
CFLOW	140	A	($/Y) CASH FLOW	CAPTS,A,163/CAPTP,A,164
CIALP	94.2	C		ALP,A,94
CIF	110	R	(1) COST INFLATION FACTOR	SPCPB,L,104/MECS,L,109/MECP,L,116/SCAP,L,154
CLH	166.1	C	(M) COMPANY DESIRED LIFE HORIZON	RCCL,A,166
CLO	167	A	(M) COMPANY ACTUAL LIFE HORIZON	RCCL,A,166
CPB	104.2	C	($/B) INITIAL PRODUCTION COST PER BARREL AT THE END OF THE YEAR	SPCPB,L,104/SPCPB,N,104.1
DAEWS	107	A	($/W) DEVIATION OF ACTUAL COST OF EXPLORATION PER WELL FROM ESTIMATED COST OF EXPLORATION PER WELL	SACES,A,106/SACEP,A,114
DAREXP	24	A	(W/M) RATE OF EXPLORATORY DRILLING(DEVELOPMENT WELLS DRILLRD UNDER PARTNERSHIP)	DMSEP,A,44/DSSEP,A,45
DAREXS	20	A	(W/M) RATE OF EXPLORATORY DRILLING(DEVELOPMENT WELLS DRILLED SOLELY)	DMSES,A,34/DSSES,A,35
DCE	22.1	C	(M) DELAY IN COMPLETING THE EXPLORATION	RCWES,R,22/RCWEP,R,41
DDFL	139	R	($/M) DEPRECIATION AND DEPLETION CASH FLOW PER MONTH	TEXP,L,132/TASSET,L,161
DEC	60.2	C	(M) DELAY IN COMPLETING THE WELLS	RRCWF,R,58/RRCWS,R,59/RRCWP,R,61
DECFL	144	R	($/M) DEPRECIATION CASH FLOW	DDFL,R,139/TDDFL,L,141
DECFLP	147	R	$/M) DEPRECIATION CASH FLOW FROM WELLS DRILLED UNDER PARTNERSHIP	DECFL,R,144/CAPIPP,L,155
DECFLS	146	R	($/M) DEPRECIATION CASH FLOW FROM WELLS DRILLED SOLELY	DECFL,R,144/CAPIPS,L,151
DECP	54.1	C	(M) DELAY IN STARTING THE COMPLETION PROCESS	WRASCS,A,51/WRASCP,A,52/DRASCS,A,53/DRASCP,A,54/RCWF,R,57
DINVP	158 158.1	L N	($) CAPITAL INVESTMENT ON DEVELOPING THE WELLS DRILLED UNDER PARTNERSHIP	DPCFLP,R,149
DINVS	157 157.1	L N	($) CAPITAL INVESTMENT ON DEVELOPING THE WELLS DRILLED SOLELY	DPCFLS,R,148
DMSEP	44	A	(W/M) MEAN VALUE OF RATE OF ADDITION OF SUCCESSFUL EXPLORATORY DEVELOPMENT WELLS DRILLED UNDER PARTNERSHIP	DRSEWP,R,39
DMSES	34	A	(W/M) MEAN VALUE OF RATE OF ADDITION OF SUCCESSFUL EXPLORATORY DEVELOPMENT WELLS DRILLED SOLELY	DRSEWS,R,33
DPCFL	145	R	($/M) DEPLETION CASH FLOW PER MONTH	DDFL,R,139/TDDFL,L,141
DPCFLP	149	R	($/M) DEPLETION CASH FLOW PER MONTH FROM WELLS DRILLED UNDER PARTNERSHIP	DPCFL,R,145/DINVP,L,158

DPCFLS	148	R	($/M) DEPLETION CASH FLOW PER MONTH FROM WELLS DRILLED SOLELY TO WELLS DRILLED SOLELY	DPCFL,R,145/DINVS,L,157
DRASCP	54	A	(W/M) START RATE OF COMPLETION OF SUCCESSFUL EXPLORATORY WELLS DRILLED UNDER PARTNERSHIP	RCWP,R,56
DRASCS	53	A	(W/M) START RATE OF COMPLETION OF SUCCESSFUL EXPLORATORY WELLS DRILLED SOLELY	RCWS,R,55
DRHOL	12	A	(ACRES) DESIRED AMOUNT OF RAW LAND HOLDINGS	RALA,R,5/RULFO,R,10
DRSEWP	39	R	(W/M) RATE OF ADDITION OF SUCCESSFUL EXPLORATORY "DEVELOPMENT" WELLS DRILLED UNDER PARTNERSHIP	TRSEWP,R,42/DTSEWP,L,46/DRASCP,A,54
DRSEWS	33	R	(W/M) RATE OF ADDITION OF SUCCESSFUL EXPLORATORY "DEVELOPMENT" WELLS DRILLED SOLELY	DTSEWS,L,36/TRSEWS,R,37/DRASCS,A,53
DSRP	44.1	C	(1) SUCCESS RATIO OF EXPLORATORY " DEVELOPMENT" WELLS DRILLED UNDER PARTNERSHIP	DMSEP,A,44
DSRS	34.1	C	(1) SUCCESS RATIO OF EXPLORATORY " DEVELOPMENT" WELLS DRILLED SOLELY	DMSES,A,34
DSSEP	45	A	(W/M) STANDARD DEVIATION OF RATE OF ADDITION OF SUCCESSFUL EXPLORATORY " DEVELOPMENT" WELLS DRILLED UNDER PARTNERSHIP	DRSEWP,R,39
DSSES	35	A	(W/M) STANDARD DEVIATION OF RATE OF ADDITION OF SUCCESSFUL EXPLORATORY " DEVELOPMENT" WELLS DRILLED SOLELY DT (M) SOLUTION INTERVAL	DRSEWS,R,33
DTSEWP	46 46.1	L N	(W) CUMULATIVE NUMBER OF SUCCESSFUL EXPLORATORY "DEVELOPMENT" WELLS DRILLED UNDER PARTNERSHIP	
DTSEWS	36 36.1	L N	(W) CUMULATIVE NUMBER OF SUCCESSFUL EXPLORATORY "DEVELOPMENT" WELLS DRILLED SOLELY	
ECPEWP	115	A	($/W) ESTIMATED COST OF EXPLORATION PER WELL TO BE DRILLED UNDER PARTNERSHIP	AREXPP,R,18/SACEP,A,114
ECPEWS	108	A	($/W) ESTIMATED COST OF EXPLORATION PER WELL TO BE DRILLED SOLELY	AREXPS,R,17/SACES,A,106
EXPF	16	A	(W/M) RATE OF EXPLORATORY DRILLING OF FARMED OUT WELLS	MSEF,A,48/SSEF,A,49
FF	121.1	C	(1) PROPORTION OF SALES REVENUE FROM FARMED OUT WELLS	TSRF,A,121
FP	102.3	C		PCIF,R,102
FRSGA	131.1	C	(1) FRACTION CHARGED TO GENERAL AND ADMINISTRATION EXPENSES	GAEXR,R,131
GAEXR	131	R	($/M) GENERAL AND ADMINISTRATION EXPENSES RATE	TEXP,L,132
IALP	94.1	C	(B/W/M) INITIAL VALUE OF ALLOWABLE RATE OF PRODUCTION	ALP,A,94
ICIF	110.1	C	(1) COST INFLATION FACTOR	CIF,R,110
IPIF	102.1	C	(1) PRICE INFLATION FACTOR	PCIF,R,102
ISCAP	154.2	C	($/B/M) COST OF ADDING PRODUCTION CAPACITY TO PRODUCE ONE BARREL OF OIL PER MONTH	SCAP,L,154/SCAP,N,154.1
IVL	102.2	C		PCIF,R,102
LAPR	168	A	(B/M) LONG TERM AVERAGE PRODUCTION RATE	CLO,A,167
LAPRP	100 100.1	L N	(B/M) LONG TERM AVERAGE PRODUCTION RATE FROM WELLS COMPLETED UNDER PARTNERSHIP	LAPR,A,168

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LAPRS     99    L  (B/M) LONG TERM AVERAGE PRODUCTION RATE      LAPR,A,168
          99.2  N    FROM WELLS COMPLETED SOLELY
LENGTH   169.7  C  (M) SIMULATED DURATION
LTAS      99.1  C  (M) LONG TERM PRODUCTION AVERAGING TIME      LAPRS,L,99/LAPRP,L,100
MAPT     165    A  (1) MULTIPLIER TO INCREASE EXPLORATION WHEN CAPTS,A,163/CAPTP,A,164
                     COMPANY"S LIFE RATIO FALLS
MECP     116    L  ($/W) MEAN VALUE OF ESTIMATED COST OF        ECPEWP,A,115
         116.1  N    EXPLORATION PER WELL DRILLED UNDER
                     PARTNERSHIP
MECS     109    L  ($/W) MEAN VALUE OF ESTIMATED COST OF        ECPEWS,A,108
         109.1  N    EXPLORATION PER WELL DRILLED SOLELY
MEXP       8.2  C  (M) EXPIRY TIME OF RAW LAND HOLDINGS         RALA,R,5/RULFO,R,10/DRHOL,A,12/ARALA,A,13/ARULD,A,14
MFO       10.2  C  (1) MAX FRACTION OF ACREAGE FARMED OUT       RULFO,R,10
MPRF      85.1  C  (B/W) MEAN PROVEN RESERVES PER FARMED OUT    SAPURF,A,85
                     WELL
MPRP      82    A  (B/W) MEAN PROVEN RESERVES PER WELL DRILLED SAPURP,A,81
                     UNDER PARTNERSHIP
MPRPW     95    A  (1) TABLE GIVING MULTIPLIER FOR RATE OF      PRS,R,91/PRP,R,92/PRF,R,93
                     PRODUCTION CAPACITY ADDITION
MPRS      76    A  (B/W) MEAN PROVEN RESERVES PER WELL DRILLED SAPURS,A,75
                     SOLELY
MQC        3.1  C  (1) MEAN QUALITY COEFFICIENT OF GEOLOGICAL   QCGI,A,3
                     INFORMATION
MSEF      48    A  (W/M) MEAN VALUE OF RATE OF ADDITION OF      RSEWF,R,47
                     SUCCESSFUL EXPLORATORY FARMED OUT WELLS
MSEP      30    A  (W/M) MEAN VALUE OF RATE OF ADDITION OF      WRSEWP,R,29
                     SUCCESSFUL EXPLORATORY WILD CAT WELLS
                     DRILLED UNDER PARTNERSHIP
NPRPWF    90.1  C                                               RCPF,A,90/STAPF,N,98.1
NPRPWP    89.1  C  (B/W/M) NORMAL VALUE OF DESIRED PRODUCTION   RCPP,A,89/STAPP,N,97.1
                     RATE PER WELL COMPLETED UNDER PARTNERSHIP
NPRPWS    88.1  C  (B/W/M) NORMAL VALUE OF DESIRED PRODUCTION   RCPS,A,88/STAPS,N,96.1
                     RATE PER WELL COMPLETED SOLELY
NVREP    164.2  C  (1) NORMAL VALUE FOR FRACTION OF CASH FLOW   CAPTP,A,164
                     RETAINED FOR EXPLORATION(DRILL UNDER
                     PARTNERSHIP)
NVRES    164.1  C  (1) NORMAL VALUE FOR FRACTION OF CASH FLOW   CAPTS,A,163
                     RETAINED FOR EXPLORATION SPENDING(DRILL
                     SOLELY)
PB       101.2  C  ($/B) BASE VALUE OF PRICE PER BARREL         PPB,L,101/PPB,N,101.1
PBT      135    A  ($/Y) PROFIT BEFORE TAX                      ATP,A,136
PCIF     102    R  (1) RATIO REFLECTING RATE OF PRICE INCREASE PPB,L,101
PCPB     103    A  ($/B) PRODUCTION COST PER BARREL             RCP,R,126
PDP       18.2  N  (1/M) PROPORTION OF RAW LAND HOLDINGS TO BE AREXPP,R,18
                     USED FOR DRILLING UNDER PARTNERSHIP
PDS       18.1  N  (1/M) PROPORTION OF RAW LAND HOLDINGS TO BE AREXPS,R,17
                     USED FOR SOLE DRILLING
PFO        9.1  C  (1) PROPORTION OF RAW LAND HOLDINGS FARMED   RULFON,A,9
                     OUT
PLTPER                                                          LENGTH,C,169.7
PPB      101    L  ($/B) PRICE PER BARREL                       TSRS,A,119/TSRP,A,120/TSRF,A,121
         101.1  N
PRF       93    R  (B/M) PRODUCTION RATE FROM FARMED OUT WELLS TPRF,L,86/STAPF,L,98
PRP       92    R  (B/M) PRODUCTION RATE FROM WELLS COMPLETED   TPRP,L,78/STAPP,L,97/LAPRP,L,100
                     UNDER PARTNERSHIP
PRS       91    R  (B/M) PRODUCTION RATE FROM WELLS COMPLETED   TPRS,L,72/STAPS,L,96/LAPRS,L,99
                     SOLELY
PRTPER             (M) PRINTING INTERVAL                        LENGTH,C,169.7
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QCGI	3	A	(1) QUALITY COEFFICIENT OF GEOLOGICAL INFORMATION	ACPA,A,2/QCGITLP,A,77
QCGITLP	77	A	(1) QUALITY COEFFICIENT OF GEOLOGICAL INFORMATION AT TIME OF LEASING	MPRS,A,76/MPRP,A,82
RAAST	162	R	($/M) RATE OF ADDITION OF ASSETS	TASSET,L,161
RALA	5	R	(ACRES/M) RATE OF ACQUISITION OF ACREAGE PER MONTH	RLHOL,L,6/ARALA,A,13
	5.1	N		
RCCL	166	A	(1) RATIO OF ACTUAL COMPANY'S LIFE TO COMPANY'S DESIRED LIFE HORIZO	MPRPW,A,95/MAPT,A,165
RCCP	130	R	($/M) COST OF COMPLETION(WELLS DRILLED UNDER PARTNERSHIP)	TEXP,L,132
RCCS	129	R	($/M) COST OF COMPLETION(WELLS DRILLED SOLELY)	TEXP,L,132
RCEP	128	R	($/M) COST OF EXPLORATION(WELLS DRILLED UNDER PARTNERSHIP)	TEXP,L,132
RCES	127	R	($/M) COST OF EXPLORATION(WELLS DRILLED SOLELY)	TEXP,L,132
RCL	137	R	($/M) COST OF ACREAGE	TEXP,L,132
RCP	126	R	($/M) COST OF PRODUCTION PER MONTH	TEXP,L,132
RCPF	90	A	(B/M**2) RATE OF ADDITION OF PRODUCTION CAPACITY TO FARMED OUT WELLS	
RCPP	89	A	(B/M**2) RATE OF ADDITION OF PRODUCTION CAPACITY TO WELLS DRILLED UNDER PARTNERSHIP	RSPCPP,R,156
RCPS	88	A	(B/M**2) RATE OF ADDITION OF PRODUCTION CAPACITY TO WELLS DRILLED SOLELY	RSPCPS,R,152
RCWEP	41	R	(W/M) RATE OF COMPLETION OF EXPLORATORY DRILLING(WELLS DRILLED UNDER PARTNERSHIP	TWEP,L,40/RCEP,R,128
RCWES	22	R	(W/M) RATE OF COMPLETION OF EXPLORATORY DRILLING(WELLS DRILLED SOLELY	TWES,L,21/RCES,R,127
RCWF	57	R	(W/M) START RATE OF COMPLETION OF FARMED OUT WELLS	RRCWF,R,58
RCWP	56	R	(W/M) START RATE OF COMPLETION OF WELLS DRILLED UNDER PARTNERDHIP	RRCWP,R,61/TCWP,L,62
RCWS	55	R	(W/M) START RATE OF COMPLETION OF WELLS DRILLED SOLELY	RRCWS,R,59/TCWS,L,60
RDPWF	70	R	(W/M) RATE OF DECAY OF PRODUCING FARMED OUT WELLS	TPWF,L,69
RDPWP	67	R	(W/M) RATE OF DECAY OF PRODUCING WELLS COMPLETED UNDER PARTNERSHIP	TPWP,L,66
RDPWS	64	R	(W/M) RATE OF DECAY OF PRODUCING WELLS COMPLETED SOLELY	TPWS,L,63
RLA	4	A	(ACRES/M) RATE OF ACQUISITION OF ACREAGE	RALA,R,5/RALA,N,5.1
RLEXP	15	R	(ACRES/M) RATE OF EXPIRY OF RAW LAND HOLDINGS	RLHOL,L,6
RLHOL	6	L	(ACRES) AMOUNT OF RAW LAND HOLDINGS	RALA,R,5/RULFO,R,10/AREXPS,R,17/AREXPP,R,18/RCL,R,137
	6.1	N		
ROI	150	A	(%/Y) RETURN ON INVESTMENT	
RORP	138.1	C	(1) RATE OF ROYALTY PAYMENTS	TRP,R,138
RPRF	87	R	(B/M) RATE OF ADDITION OF PROVEN RESERVES TO FARMED OUT WELLS	TPRF,L,86
RPRP	79	R	(B/M) RATE OF ADDITION OF PROVEN RESERVES TO WELLS DRILLED UNDER PARTNERSHIP	TPRP,L,78
RPRS	73	R	(B/M) RATE OF ADDITION OF PROVEN RESERVES TO WELLS DRILLED SOLELY	TPRS,L,72
RRCWF	58	R	(W/M) RATE OF COMPLETION OF FARMED OUT WELLS	TPWF,L,69/RPRF,R,87/RCPF,A,90

RRCWP	61	R	(W/M) RATE OF COMPLETION OF WELLS DRILLED UNDER PARTNERSHIP	TCWP,L,62/TPWP,L,66/RPRP,R,79/RCPP,A,89/RCCP,R,130/RTCDP,R,160
RRCWS	59	R	(W/M) RATE OF COMPLETION OF WELLS DRILLED SOLELY	TCWS,L,60/TPWS,L,63/RPRS,R,73/RCPS,A,88/RCCS,R,129/RTCDS,R,159
RSALE	125	R	($/M) RATE OF SALES REVENUE RECEIVED PER MONTH	TSALE,L,122/GAEXR,R,131/TRP,R,138
RSEWF	47	R	(W/M) RATE OF ADDITION OF SUCCESSFUL EXPLORATORY FARMED OUT WELLS	TWSEF,L,50/RCWF,R,57
RSPCPP	156	R	($/M**2) RATE OF ADDITION OF INVESTMENT TO PRODUCTION CAPACITY OF WELLS DRILLED UNDER PARTNERSHIP	TEXP,L,132/CAPIPP,L,155/RAAST,R,162
RSPCPS	152	R	($/M**2) RATE OF ADDITION OF INVESTMENT TO PRODUCTION CAPACITY OF WELLS DRILLED SOLELY	TEXP,L,132/CAPIPS,L,151/RAAST,R,162
RTCDP	160	R	($/M) RATE OF ADDITION OF INVESTMENT ON DEVELOPMENT TO WELLS DRILLED UNDER PARTNERSHIP	DINVP,L,158/RAAST,R,162
RTCDS	159	R	($/M) RATE OF ADDITION OF INVESTMENT ON DEVELOPMENT TO WELLS DRILLED SOLELY	DINVS,L,157/RAAST,R,162
RULDP	8	R	(ACRES/M) RATE OF USAGE OF RAW LAND HOLDINGS FOR EXPLORATORY DRILLING(DRILLEDUNDER PARTNERSHIP)	RLHOL,L,6/ANRULD,A,11/ARULD,A,14
RULDS	7	R	(ACRES/M) RATE OF USAGE OF RAW LAND HOLDINGS FOR EXPLORATORY DRILLING (DRILLED SOLELY)	RLHOL,L,6/ANRULD,A,11/ARULD,A,14
RULFO	10	R	(ACRES/M) RATE OF ACREAGE FARMED OUT	RLHOL,L,6/ARULD,A,14/EXPF,A,16
	10.1	N		
RULFON	9	A	(ACRES/M) RATE OF ACREAGE NORMALLY FARMED OUT	RULFO,R,10/RULFO,N,10.1/ANRULD,A,11
SACEP	114	A	($/W) SAMPLE VALUE OF AVERAGE COST OF EXPLORATION PER WELL DRILLED UNDER PARTNERSHIP	ACEPWP,A,113
SACES	106	A	($/W) SAMPLE VALUE OF ACERAGE COST OF EXPLORATION PER WELL DRILLED SOLELY	ACEPWS,A,105
SADEP	118	A	($/W) SAMPLE VALUE OF AVERAGE COST OF DEVELOPMENT PER WELL DRILLED UNDER PARTNERSHIP	ACDPWP,A,117
SADES	112	A	($/W) SAMPLE VALUE OF AVERAGE COST OF DEVELOPMENT PER WELL DRILLED SOLELY	ACDPWS,A,111
SAPURF	85	A	(B/W) SAMPLE VALUE OF AVERAGE PROVEN RESERVES PER FARMED OUT WELL	APURF,A,84
SAPURP	81	A	(B/W) SAMPLE VALUE OF AVERAGE PROVEN RESERVES PER WELL DRILLED UNDER PARTNERSHIP	APURP,A,80
SAPURS	75	A	(B/W) SAMPLE VALUE OF AVERAGE PROVEN RESERVES PER WELL DRILLED SOLELY	APURS,A,74
SAVPER				LENGTH,C,169.7
SCAP	154	L	($/(B/M)) SAMPLE VALUE OF CAPCAP	CAPCAP,A,153
	154.1	N		
SECP	115.1	C	($/W) STANDARD DEVIATION OF ESTIMATED COST OF EXPLORATION PER WELL DRILLED UNDER PARTNERSHIP	ECPEWP,A,115
SECS	108.1	C	($/W) STANDARD DEVIATION OF ESTIMATED COST OF EXPLORATION PER WELL DRILLED SOLELY	ECPEWS,A,108
SPCPB	104	L	($/B) COST OF PRODUCTION PER BARREL	PCPB,A,103
	104.1	N		
SPRF	87.1	C	(B/W) STANDARD DEVIATION OF AVERAGE PROVEN RESERVES PER FARMED OUT WELL	SAPURF,A,85

SPRP	82.2	C	(B/W) STANDARD DEVIATION OF AVERAGE PROVEN RESERVES PER WELL DRILLED UNDER PARTNERSHIP	SAPURP,A,81
SPRS	76.2	C	(B/W) STANDARD DEVIATION OF AVERAGE PROVEN RESERVES PER WELL DRILLED SOLELY	SAPURS,A,75
SPW	8.1	C	(ACRES/W) SPACING PER WELL	RULDS,R,7/RULDP,R,8/EXPF,A,16/AREXPS,R,17/AREXPP,R,18
SQC	3.2	C	(1) STANDARD DEVIATION OF QUALITY COEFFICIENT OF GEOLOGICAL INFORMATION	QCGI,A,3
SSEF	49	A	(W/M) STANDARD DEVIATION OF RATE OF ADDITION OF SUCCESSFUL EXPLORATORY FARMED OUT WELLS DRILLED	RSEWF,R,47
SSEP	31	A	(W/M) STANDARD DEVIATION OF RATE OF ADDITION OF SUCCESSFUL EXPLORATORY WILD CAT WELLS DRILLED UNDER PARTNERSHIP	WRSEWP,R,29
STAF	98.2	C	(M) SMOOTHING FACTOR OF SHORT TERM AVERAGE PRODUCTION RATE FOR FARMED WELLS	STAPF,L,98
STAP	97.2	C	(M) SMOOTHING FACTOR OF SHORT TERM AVERAGE PRODUCTION RATE FOR WELLS DRILLED UNDER PARTNERSHIP	STAPP,L,97
STAPF	98 98.1	L N	(B/M) SHORT TERM AVERAGE PRODUCTION RATE FROM FARMED OUT WELLS	AWLF,A,71/TSRF,A,121
STAPP	97 97.1	L N	(B/M) SHORT TERM AVERAGE PRODUCTION RATE FROM WELLS DRILLED UNDER PARTNERSHIP	AWLP,A,68/LAPRP,N,100.1/TSRP,A,120/RCP,R,126/DPCFLP,R,149
STAPS	96 96.1	L N	(B/M) SHORT TERM AVERAGE PRODUCTION RATE FROM WELLS DRILLED SOLELY	AWLS,A,65/LAPRS,N,99.2/TSRS,A,119/RCP,R,126/DPCFLS,R,148
STAS	96.2	C	(M) SMOOTHING FACTOR OF SHORT TERM AVERAGE PRODUCTION RATE FOR WELLS DRILLED SOLELY	STAPS,L,96
TAB1	2.1	T	($/ACRE/M) TABLE GIVING COST OF ACREAGE	ACPA,A,2
TAB2	4.2	T	(BLOCKS/Y) TABLE GIVING BLOCKS OF ACREAGE ACQUIRED PER YEAR	RLA,A,4
TAB6	165.1	T	(1) TABLE GIVING MULTIPLIER FOR EXPLORATION SPENDING	MAPT,A,165
TAB7	76.1	T	(B/W) TABLE GIVING AVERAGE PROVEN RESERVES PER WELL DRILLED SOLELY	MPRS,A,76
TAB8	82.1	T	(B/W) TABLE GIVING AVERAGE PROVEN RESERVES PER WELL DRILLED UNDER PARTNERSHIP	MPRP,A,82
TASSET	161 161.1	L N	($) TOTAL ASSETS	ROI,A,150
TAX	136.1	C	(1) TAX RATE	ATP,A,136
TCWP	62 62.1	L N	(W) TOTAL WELLS IN THE PROCESS OF COMPLETION(DRILLED UNDER PARTNERSHIP)	
TCWS	60 60.1	L N	(W) TOTAL WELLS IN THE PROCESS OF COMPLETION(DRILLED SOLELY)	
TDDFL	141 141.1	L N	($) TOTAL DEPRECIATION AND DEPLETION CASH FLOW	TDFLR,A,142/CBDFL,R,143
TDFLR	142	A	($/Y) DEPRECIATION AND DEPLETION CASH FLOW REPORTED	CFLOW,A,140
TEXP	132 132.2	L N	($) TOTAL EXPENDITURE	TEXPR,A,133/CEXP,R,134
TEXPR	133	A	($/Y) TOTAL EXPENDITURE REPORTED	PBT,A,135
TPRES	83	A	(B) TOTAL PROVEN RESERVES	CLO,A,167
TPRF	86 86.1	L N	(B) TOTAL PROVEN RESERVES FROM FARMED OUT WELLS	AWLF,A,71
TPRP	78 78.1	L N	(B) TOTAL PROVEN RESERVES FROM WELLS COMPLETED UNDER PARTNERSHIP	AWLP,A,68/TPRES,A,83/DPCFLP,R,149
TPRPW	95.1	T	(1) TABLE GIVING MULTIPLIERS FOR DESIRED PRODUCTION RATE PER WELL PER MONTH	MPRPW,A,95

TPRS	72 72.1	L N	(B) TOTAL PROVEN RESERVES FROM WELLS COMPLETED SOLELY	AWLS,A,65/TPRES,A,83/DPCFLS,R,148
TPWF	69 69.1	L N	(W) TOTAL PRODUCING FARMED OUT WELLS	RDPWF,R,70/PRF,R,93/STAPF,N,98.1
TPWP	66 66.1	L N	(W) TOTAL PRODUCING WELLS(COMPLETED UNDER PARTNERSHIP)	RDPWP,R,67/PRP,R,92/STAPP,N,97.1
TPWS	63 63.1	L N	(W) TOTAL PRODUCING WELLS(COMPLETED SOLELY)	RDPWS,R,64/PRS,R,91/STAPS,N,96.1
TRP	138	R	($/M) ROYALTY PAYMENTS	TEXP,L,132
TRSEWP	42	R	(W/M) RATE OF ADDITION OF SUCCESSFUL EXPLORATORY WELLS DRILLED UNDER PARTNERSHIP	TWSEP,L,43
TRSEWS	37	R	(W/M) RATE OF ADDITION OF SUCCESSFUL EXPLORATORY WELLS DRILLED SOLELY	TWSES,L,38
TSALE	122 122.1	L N	$) TOTAL SALES REVENUE	CBSALE,R,123/TSALER,A,124
TSALER	124	A	($/Y) TOTAL SALES REVENUE REPORTED	PBT,A,135
TSRF	121	A	($/M) SALES REVENUE PROCEEDING TO THE COMPANY FROM FARMED OUT WELLS	RSALE,R,125
TSRP	120	A	($/M) SALES REVENUE RECEIVED FROM WELLS DRILLED UNDER PARTNERSHIP	RSALE,R,125
TSRS	119	A	($/M) SALES REVENUE RECEIVED FROM WELLS DRILLED SOLELY	RSALE,R,125
TTARA	11.1	C	(M) TIME TO AVERAGE RATE OF ACQUISITION OF RAW LAND	ANRULD,A,11
TWEP	40 40.1	L N	(W) TOTAL WELLS IN EXPLORATION PROCESS(DRILLED UNDER PARTNERSHIP)	
TWES	21 21.1	L N	(W) TOTAL WELLS IN EXPLORATION PROCESS(DRILLED SOLELY)	
TWSEF	50 50.1	L N	(W) CUMULATIVE NUMBER OF SUCCESSFUL EXPLORATORY FARMED OUT WELLS	
TWSEP	43 43.1	L N	(W) CUMULATIVE NUMBER OF SUCCESSFUL EXPLORATORY WELLS DRILLED UNDER PARTNERSHIP	
TWSES	38 38.1	L N	(W) CUMULATIVE NUMBER OF SUCCESSFUL EXPLORATORY WELLS DRILLED SOLELY	
URFF	71.1	C	(1) ULTIMATE RECOVERY FACTOR(FARMED OUT WELLS)	AWLF,A,71
URFP	68.1	C	(1) ULTIMATE RECOVERY FACTOR(WELLS DRILLED UNDER PARTNERSHIP)	AWLP,A,68
URFS	65.1	C	(1) ULTIMATE RECOVERY FACTOR(WELLS DRILLED SOLELY)	AWLS,A,65
WAREXP	23	A	(W/M) RATE OF EXPLORATORY DRILLING (WILD CAT WELLS DRILLED UNDER PARTNERSHIP)	MSEP,A,30/SSEP,A,31
WAREXS	19	A	(W/M) RATE OF EXPLORATORY DRILLING (WILD CAT WELLS DRILLED SOLELY)	WMSES,A,26/WSSES,A,27
WMSES	26	A	(W/M) MEAN VALUE OF RATE OF ADDITION OF SUCCESSFUL EXPLORATORY WILD CAT WELLS DRILLED SOLEY	WRSEWS,R,25
WP	24.1	C	(1) PROPORTION OF RATE OF EXPLORATORY DRILLING WITH PARTNER WHICH ARE WILD CAT WELLS	WAREXP,A,23/DAREXP,A,24
WRASCP	52	A	(W/M) START RATE OF COMPLETION OF SUCCESSFUL EXPLORATORY WILD CAT WELLS DRILLED UNDER PARTNERSHIP	RCWP,R,56
WRASCS	51	A	(W/M) START RATE OF COMPLETION OF SUCCESSFUL EXPLORATORY WILD CAT WELLS DRILLED SOLELY	RCWS,R,55

WRSEWP	29	R	(W/M) RATE OF ADDITION OF SUCCESSFUL EXPLORATORY WILD CAT WELLS DRILLED UNDER PARTNERSHIP	WTSEWP,L,32/TRSEWP,R,42/WRASCP,A,52
WRSEWS	25	R	(W/M) RATE OF ADDITION OF SUCCESSFUL EXPLORATORY WILD CAT WELLS DRILLED SOLELY	WTSEWS,L,28/TRSEWS,R,37/WRASCS,A,51
WS	20.1	C	(1) PROPORTION OF RATE OF EXPLORATORY DRILLING(DRILLED SOLELY)WHICH IS WILD CAT WELLS	WAREXS,A,19/DAREXS,A,20
WSRF	48.1	C	(1) SUCCESS RATIO OF EXPLORATORY FARMED OUT WELLS	MSEF,A,48
WSRP	30.1	C	(1) SUCCESS RATIO OF EXPLORATORY WILD CAT WELLS DRILLED UNDER PARTNERSHIP	MSEP,A,30
WSRS	26.1	C	(1) SUCCESS RATIO OF EXPLORATORY WILD CAT WELLS DRILLED SOLELY	WMSES,A,26
WSSES	27	A	(W/M) STANDARD DEVIATION OF RATE OF ADDITION OF SUCCESSFUL EXPLORATORY WILD CAT WELLS DRILLED SOLEY	WRSEWS,R,25
WTSEWP	32 32.1	L N	(W) CUMULATIVE NUMBER OF SUCCESSFUL EXPLORATORY WILD CAT WELLS DRILLED UNDER PARTNERSHIP	
WTSEWS	28 28.1	L N	(W) CUMULATIVE NUMBER OF SUCCESSFUL EXPLORATORY WILD CAT WELLS DRILLED SOLELY	