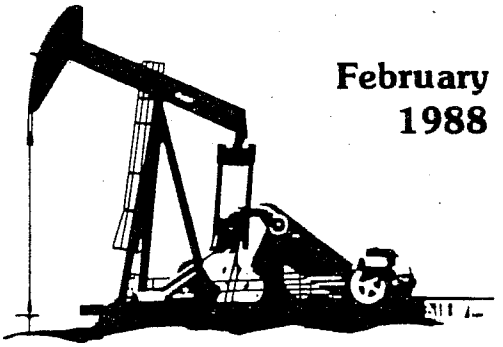
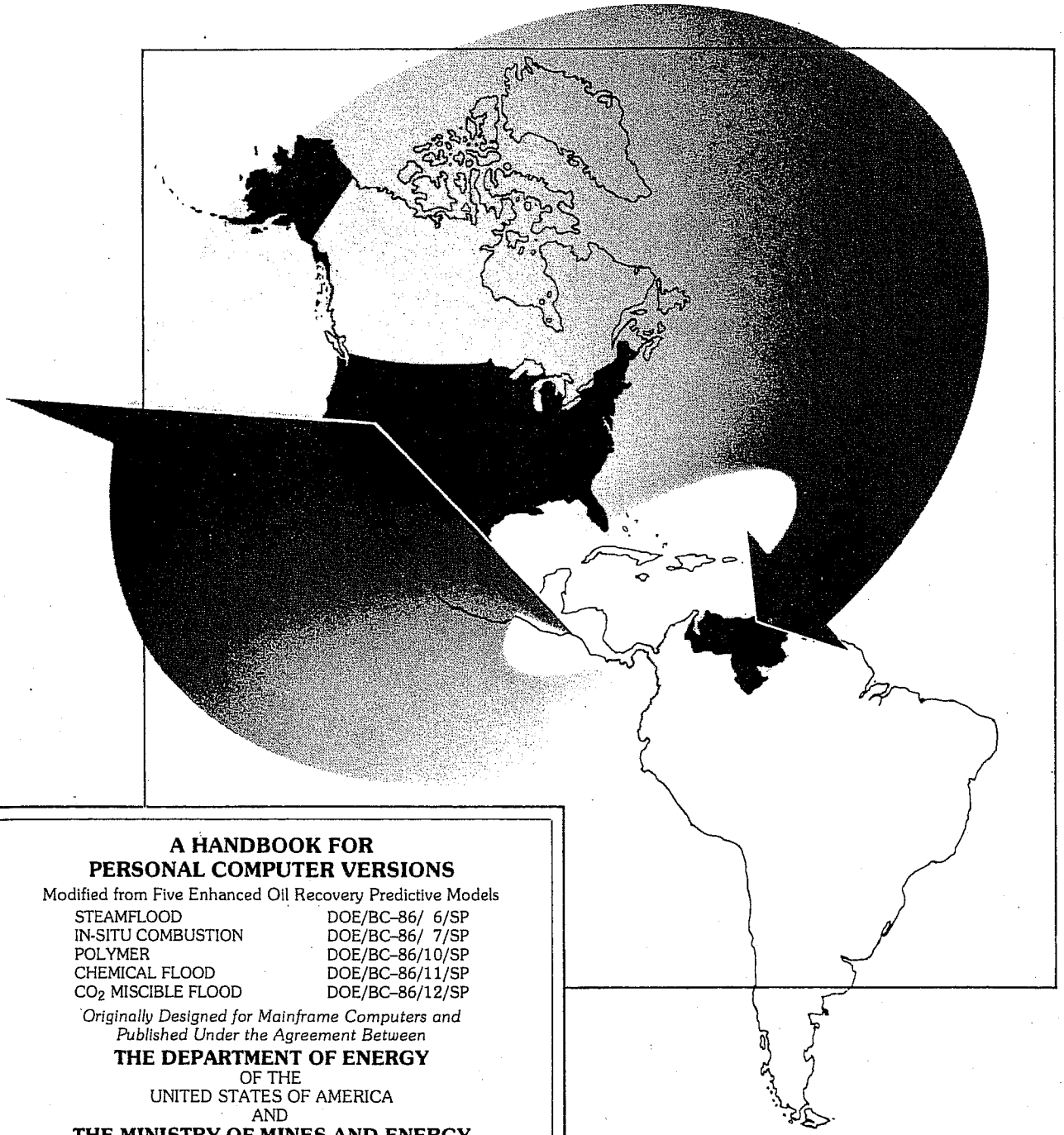
SUPPORTING TECHNOLOGY FOR ENHANCED OIL RECOVERY



February 1988

HANDBOOK FOR PERSONAL COMPUTER VERSIONS OF ENHANCED OIL RECOVERY PREDICTIVE MODELS



A HANDBOOK FOR PERSONAL COMPUTER VERSIONS

Modified from Five Enhanced Oil Recovery Predictive Models

STEAMFLOOD	DOE/BC-86/ 6/SP
IN-SITU COMBUSTION	DOE/BC-86/ 7/SP
POLYMER	DOE/BC-86/10/SP
CHEMICAL FLOOD	DOE/BC-86/11/SP
CO_2 MISCIBLE FLOOD	DOE/BC-86/12/SP

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HANDBOOK FOR PERSONAL COMPUTER VERSIONS OF ENHANCED OIL RECOVERY PREDICTIVE MODELS

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February 1988

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CONTENTS

1.0 INTRODUCTION

The personal computer (PC) programs described in this handbook were adapted from the Tertiary Oil Recovery Information System (TORIS) enhanced oil recovery (EOR) predictive models. The models, both those developed for the Department of Energy and those developed for the National Petroleum Council (NPC), were designed by Scientific Software-Intercomp and were used in the 1984 NPC study on the national potential for enhanced oil recovery. The Department of Energy, Bartlesville Project Office, supported the NPC study and has maintained the models since the study was completed.

The architecture of the various predictive models is similar. An oil-rate-versus-time function for a single pattern is computed, and the results are passed to the economic routines. Data for process, reservoir development and operating costs, and a pattern schedule (if multiple patterns are desired) allow the computation of discounted cash flow and other measures of profitability. The PC versions of the EOR predictive models also allow the plotting of selected reservoir flood data.

The models have been described in detail in publications, which are referenced in following sections; therefore, a detailed description will not be included in this report. This report does briefly describe the predictive algorithms used, the general economic routines employed, and describes the procedure necessary to load and implement the models on a personal computer.

The use of personal computers is increasing significantly, and with the myriad of hardware options available, there is no "standard" hardware configuration. The predictive model routines discussed in this report and distributed on diskette require a system equivalent to an IBM PC-AT with 640 KB of random access memory, a math coprocessor, and a high-density disk drive (1.2 MB); this hardware is in widespread use as of this writing. No provision has been made to accommodate different hardware.

2.0 MODEL DESCRIPTIONS, ASSUMPTIONS, AND LIMITATIONS

The Enhanced Oil Recovery (EOR) predictive models are not simulators but rather simplified models that use average values for reservoir characteristics such as porosity and permeability. The models require the user to input reservoir, process, fluid, and economic data in order to estimate the pattern oil recovery, project oil recovery, and project economic schedules. The user should supply all data values that are available; and the models will provide default values for missing, non-critical data. Critical

input data is denoted by the word "required" in the data input listings contained in Appendices A through E. To use the default value, the user inputs a value of 0 (0.0 if REAL number). Predictive algorithm accuracies are increased and more meaningful results are produced if fewer values are defaulted.

2.1 STEAMFLOOD PREDICTIVE MODEL

The Steamflood Predictive Model (SFPM) was developed by Scientific Software-Intercomp for the Department of Energy, and was used by the NPC in its 1984 survey of enhanced oil recovery potential (NPC, 1984). In the 1984 version of the model, there were four predictive algorithms to calculate oil recovery, but the NPC used only one predictive routine - that based on empirical calculations as described by Gomaa (1980). Due to space limitations, this version for personal computers contains only the Gomaa-based predictive routine. The other routines are supplied with the minicomputer and mainframe version of the model, and are described in publication DOE/BC-86/6/SP.

The SFPM is applicable to the steam drive process, but, by design, is not applicable to the cyclic steam injection (steam soak) process. The Gomaa correlations were developed to estimate the oil recovery in shallow, unconsolidated sands containing heavy oil, and to predict vertical heat losses, vertical sweep, and oil recovery as functions of reservoir thickness, heat injected, bottom-hole steam quality, and mobile oil saturation. Additions to the original Gomaa routines include a simple method of estimating water production rates, calculations for heat loss in surface pipe and wellbore, and a recovery correlation adjustment for reservoirs with dip angles between 10 and 50 degrees. This predictive model is applicable to reservoirs with the general range of properties shown in table 1. The reader is also encouraged to review the publication DOE/BC-86/6/SP for additional information about the applicability of using the model.

Table 1: Range of reservoir properties used to develop Gomaa model

Porosity	0.21 - 0.35
Gross Reservoir thickness, ft.	10 - 300
Net/gross thickness ratio	0.6 - 1.0
Steam quality, percent	0 - 100
Heat injection rate MMBtu/d/acre ft.	0.05 - 0.6
Mobile oil saturation	0.05 - 0.6

2.2 IN-SITU COMBUSTION PREDICTIVE MODEL

The In-situ Combustion Predictive Model (ICPM) was developed by Scientific Software-Intercomp for the NPC for its 1984 survey (NPC, 1984). A detailed description of the model and the FORTRAN source code listing is contained in publication DOE/BC-86/7/SP.

The ICPM oil recovery algorithm is based on the work of Brigham et al. (1980), who correlated the major variables in the combustion process with the results of 12 field tests. The correlation relates oil burned and oil produced to the amount of air injected and the reservoir volume for dry combustion. The NPC added calculations for wet combustion based on laboratory data.

The assumptions and limitations of the ICPM are: 1) no free gas saturation, 2) empirical sweep efficiency based on pattern size, 3) constant air-to-fuel ratio of 70 MCF air burned/bbl oil burned, 4) produced water = injected water + water displaced during combustion - water remaining in burned volume, 5) water saturation in burned volume is 20% for wet combustion, 0% for dry combustion, 6) produced gas = injected nitrogen + gaseous reaction products - gas contained in burned volume, 7) amount of reaction gases is two-thirds of injected oxygen, 8) gas saturation in burned volume is 80% for wet combustion, 0% for dry combustion, 9) air injection rate based on 10 year pattern life, 10) constant air injection rate after first year of project, 11) production-to-injection well ratio is 2:1 (this value represents an inverted seven-spot pattern, or a midpoint between an inverted five-spot pattern and nine-spot pattern development).

2.3 POLYMER FLOOD PREDICTIVE MODEL

The Polymer Flood Predictive Model (PFPM) was developed by Scientific Software-Intercomp for the NPC and was used in the NPC 1984 study (NPC, 1984). The comprehensive model description and FORTRAN source code listing are contained in publication DOE/BC-86/10/SP.

The PFPM is a three-dimensional (stratified, five-spot), two-phase (water and oil) model which computes water front breakthrough and oil recovery using Buckley-Leverett (1942) fractional flow theory, and models areal and vertical sweeps using a streamtube approach. A correlation based on numerical simulation results is used to model the polymer slug size effect. The physical properties of polymer fluids, such as adsorption, permeability reduction, and non-Newtonian effects, are included in the model. Pressure drop between the injector and producer is kept constant, and the injectivity at each time step is calculated based on the

mobility in each streamtube. Heterogeneity is accounted for by either entering detailed layer data or using the Dykstra-Parsons coefficient for a reservoir with a log-normal permeability distribution.

The PFPM is switch selectable for either polymer or waterflooding, and an option in the model allows the calculation of the incremental oil recovery and economics of polymer relative to waterflooding.

The important assumptions of PFPM are: 1) salinity effect on polymer viscosity is negligible, 2) gravity and capillary forces are negligible, 3) no fingering occurs, 4) dispersion of the polymer concentration profile is negligible, 5) injected polymer bank completely displaces connate water with little or no mixing, 6) no crossflow between layers, 7) each layer is homogeneous in permeability, porosity, thickness, and initial water saturation, 8) inaccessible pore volume of polymer solution is negligible, 9) polymer adsorption and entrapment are instantaneous and irreversible.

2.4 CHEMICAL FLOOD PREDICTIVE MODEL

The Chemical Flood Predictive Model (CFPM) was developed by Scientific Software-Intercomp for the U.S. Department of Energy and was used in the 1984 NPC survey (NPC, 1984). A more detailed explanation of the model and the FORTRAN source code are contained in publication DOE/BC-86/11/SP.

The CFPM models micellar (surfactant)-polymer floods in reservoirs which have been previously waterflooded to residual oil saturation. An option is available in the model which allows a rough estimate of oil recovery by caustic (alkaline) or caustic-polymer processes. This "caustic" option, added for the NPC survey, is not modeled as a separate process. Rather, the caustic and caustic-polymer oil recoveries are 15% and 40%, respectively, of the micellar-polymer oil recovery.

The CFPM uses correlations derived from the results of numerical simulation to predict oil recovery. Oil-bank and surfactant breakthrough and project life are determined from fractional flow theory. A Koval-type factor, based on the Dykstra-Parsons (1950) coefficient, is used to account for the effects of reservoir heterogeneity on surfactant and oil bank velocities.

The overall oil recovery efficiency is the product of the efficiencies for 1-D displacement, vertical sweep of surfactant, and polymer sweep. The displacement efficiency is determined from the capillary number, a function of permeability, depth and well spacing. Vertical sweep

efficiency is a function of surfactant slug size, surfactant adsorption and reservoir heterogeneity. The polymer sweep efficiency is a function of the polymer slug size and the vertical sweep efficiency. The overall recovery efficiency is corrected for the effects of crossflow.

The CFPM makes the assumptions that: 1) polymer adsorption is neglected, 2) injection-production rate is constant over the life of the flood, 3) areal sweep of the micellar-polymer flood is identical to the prior waterflood, 4) peak oil production rate is assumed to be at the time of surfactant breakthrough, and 5) the oil production curve is assumed to be triangular.

2.5 CO_2 MISCIBLE FLOOD PREDICTIVE MODEL

The CO_2 Miscible Flood Predictive Model (CO2PM) was developed by Scientific Software-Intercomp for the U.S. Department of Energy and was used in the 1984 NPC survey (NPC, 1984). A more detailed description of the model and the FORTRAN source code are contained in publication DOE/BC-86/12/SP.

The CO2PM is applicable to both secondary (mobile oil) and tertiary (residual oil) floods, and to either continuous CO_2 injection or water-alternating-gas (WAG) processes.

The CO2PM is a three-dimensional (layered, five-spot), two-phase (water and oil), three-component (oil, water, and CO_2) model. It computes oil and CO_2 breakthrough and recovery from fractional flow theory[2] modified for the effects of viscous fingering, areal sweep, vertical heterogeneity and gravity segregation.

Limitations and assumptions of this model are: 1) although the CO2PM was developed for first-contact miscible floods, it can be used with confidence for multiple-contact miscible floods, 2) in general, the use of CO2PM is not recommended if the minimum miscibility pressure (MMP) between CO_2 and oil is more than 200 psi above the current reservoir pressure, 3) due to boundary condition restrictions in the method of characteristics solution of the 1-D fractional flow equations, the CO2PM cannot be used with a Koval factor below about 1.5 - 2.0 (very stable miscible displacement), 4) whether under pure CO_2 injection or WAG, the ultimate chase fluid is limited to water, 5) the model is limited to five-spot patterns, 6) no account is taken of effects of crossflow between layers, and 7) the bypassing of very heavy oils by more mobile CO_2 is not accurately predicted.

2.6 ECONOMIC CALCULATIONS

All five predictive models use similar economic analyses which will be calculated if IECON, a variable in the second line (card) of the input data, is either a 1 or 2. The economic calculations are used to convert the predicted performance data from the oil recovery algorithm into a cash flow analysis extending over the life of the project. This analysis combines forecasts of revenues, costs, expenses, and taxes into an annual balance sheet. The models also permit an evaluation of the uncertainty of future earnings as a result of changes in key variables and thus an evaluation of project risk. The user may input four types of data into the economic section:

1. Control data - These elements allow the user to select the type of output report, tax structures to be used, and allow options in the level of complexity of input data.

2. Project definition data - These elements allow the user to input the pattern development schedule, the number of wells drilled per pattern, and other pertinent project data.

3. Economic data - These elements allow the user to input prices, costs, tax rates, discount rates, escalation rates, and a capital expenditure schedule.

4. Risk data - This element allows the user to input the range of uncertainty for key variables.

The final economic results are presented in terms of five measures of profitability: Discounted cash flow, payout, discounted cash flow rate-of-return, profit-to-investment ratio, and investment efficiency. Most users will be familiar with all but investment efficiency, which is defined as the ratio of the maximum cumulative discounted cash flow at economic life to the maximum cumulative negative discounted cash flow. This is an excellent ranking method for enhanced oil recovery projects which are heavily front-end loaded with high capital and operating expenses.

3.0 USING THE PROGRAMS

This documentation is intended to be sufficient to load and run the PC versions of the EOR predictive models. It is not intended to be an exhaustive description of the models or the theory behind them. The program descriptions in this document are taken from the following DOE publications,

which include explanations of the equations, assumptions, and source code listings:

DOE/BC-86/6/SP	Steamflood Predictive Model
DOE/BC-86/7/SP	In-Situ Combustion Model
DOE/BC-86/10/SP	Polymer Predictive Model
DOE/BC-86/11/SP	Chemical Flood Predictive Model
DOE/BC-86/12/SP	CO_2 Miscible Flood Predictive Model

Three diskettes contain the predictive model executable codes, sample input and output data sets, batch files for running the models, and text files for user messages. The batch files expect the computer to be operational using DOS version 2.1 or higher.

To use the steamflood, polymer flood, in-situ combustion or the micellar-polymer flood predictive models, insert the disk labeled PREDICTIVE MODELS I and type 'TYPE MENU.TXT'. To run the CO_2 model insert the diskette labeled PREDICTIVE MODELS II and type 'TYPE MENU.TXT'. Typing this phrase will display a menu which shows the two-letter abbreviations that may be used to run the models. When the abbreviations are used, the model is run by a batch file and the menu is displayed again. The models may also be run by typing the names of the individual models. In that case, the menu is not displayed when execution is completed. If the batch files are not used to run the models, a temporary file with extension "XFR" will be left on the drive disk. This file must be deleted before another model run. In any case, the results of the run will not be displayed on the computer monitor but will be written to the output file that the user specifies.

The time required to run a model will depend on the specific equipment used and on the options for economics or plotting that are chosen. As an example, an IBM PC-AT with hard disk will run the included sample runs of the steam, in-situ, polymer, and chemical models in about 90 seconds per reservoir and will run the CO_2 model in less than seven minutes. Reading and writing data to a floppy diskette will increase each model's run time by about 30 seconds. Omitting the economic calculations and plotting routine will decrease the run time per reservoir by about 30 seconds.

3.1 SYSTEM REQUIREMENTS

The minimum system configuration for running the EOR predictive models is an IBM PC-AT (or equivalent) with a math coprocessor, a 1.2MB disk drive, and DOS Version 2.1 or later. The amount of memory required varies with the predictive model used: The CO_2 model requires 640 KB of random access memory (RAM), but the other models will run on a machine with only 512 KB of RAM. A hard disk is not

necessary, but it will increase the speed of the models. The personal computer used in adapting these PC versions of the models contained the 80286-based microprocessor. Computers using the 8086-based microprocessor or the 80386-based microprocessor have not been tested for these applications.

A certain amount of disk storage space is required to run the EOR predictive models. The output file of a model run typically occupies 50-60 KB of storage space per reservoir modeled. If the plot option is selected, the plot output file will occupy just under 32 KB of disk storage per reservoir modeled. In addition to these files, the current directory of the default drive must have at least 3 KB of free space for a temporary file that is opened by the model and deleted upon program termination. The file name for this file is supplied by DOS and will be on the current directory of the default drive. If there is insufficient space, the predictive model will be unable to run.

The plot routines require a standard line printer or any graphics printer capable of printing 132-character-wide output.

3.2 DATA INPUT/OUTPUT

Data about the subject reservoir must be in a file in the format shown in Appendices A - E. The style of the data input is also shown by the sample input files provided on the third diskette. The second line (card) of the input file includes the switch to choose economic calculations output and plot output.

The programs will ask the user for the names of the input data file, the report output file, and the plot output file if a plot is requested by the user. These file names can be up to 64 characters in length, including drive and path specifiers. The user is cautioned that if the input file does not exist, the predictive model will not run. Both the output and plot file names must be unique file names that do not already exist in the specified directory. If a file already exists with the same name, the predictive model will not run.

The output files, both text and plots, will be printed in a 132-character-wide format. The sample runs produce 14 to 20 text pages and three plot pages; other output options will produce more or less text.

3.3 PLOTTING PACKAGE

The EOR Plotting Package (EORPP) was developed to help provide the user with a graphic picture of the results from

running a predictive model on a data set. The EORPP produces three pages containing eleven or twelve plots of selected injection and production data. The plots are designed to fit on an 11" X 14" page, 132 characters wide and 80 lines long. The production data plotted by the EORPP on the first two pages are: pattern oil production, pattern water production, project oil production, project water production, cumulative project oil production, cumulative project water production, pattern water/oil ratio, and project water/oil ratio. The injection data plotted on the third page varies with the model: Steam, polymer, and CO_2 models produce plots of pattern injection volume versus time, project injection volume, and cumulative project injection volume through time. The chemical model produces four injection graphs on the third page of plots, including pattern and project injection volumes of surfactant, and pattern and project injection volumes of polymer. Similarly, the in-situ model produces plots of pattern and project volumes of air and water injected through time.

The EORPP is activated by setting IECON (Card R2 of the input data set) to 2. This will cause the economic routines to run, producing the data used by the EORPP.

3.4 DISK CONTENTS

The predictive models and the files necessary to run the models are contained on two high-density floppy diskettes. The third diskette contains sample input and output report and plot files:

Diskette 1: PREDICTIVE MODELS I (P MODELS I)

```
STEAM.EXE
INSITU.EXE
POLY.EXE
CHEM.EXE
CO.BAT
SF.BAT
IC.BAT
PF.BAT
CF.BAT
MENU.TXT
BADNEWS.TXT
```

The first four files (EXE extension) are the executable code for the steam, in-situ, polymer, and chemical flood predictive models. The next five files (BAT extension) and the last two files (TXT extension) provide the user with a simple menu method of using the models.

Diskette 2: PREDICTIVE MODELS II (P MODELS II)

CO2.EXE
CO2PLOT.EXE
CO.BAT
MENU.TXT

The first two files are the executable code for the CO_2 predictive model. The last two files provide the menu (TXT extension) and batch program (BAT extension) to run the model.

Diskette 3: PREDICTIVE MODELS III (P MODEL III)

STMIN.DAT	Steamflood Example-	Input Data
STMOUT.DAT		Report Output
STMOUT.PLT		Plots Output
INSITU.DAT	In-situ Example----	Input Data
INSITOUT.DAT		Report Output
INSITOUT.PLT		Plots Output
POLYIN.DAT	Polymer Example----	Input Data
POLYOUT.DAT		Report Output
POLYOUT.PLT		Plots Output
CHEMIN.DAT	Chemical Example---	Input Data
CHEMOUT.DAT		Report Output
CHEMOUT.PLT		Plots Output
CO2IN.DAT	CO_2 Example--------	Input Data
CO2OUT.DAT		Report Output
CO2OUT.PLT		Plots Output

These fifteen files are samples of model runs - three files for each predictive model. The first file of each model set is a sample input data file; the second file contains the report output listing; and, the third of the set contains the sample plots.

4.0 REFERENCES

Brigham, W.E., A. Satman, and M.Y. Solimon, 1980, Recovery Correlation for In-situ Combustion Field Projects and Application to Combustion Pilots: Journal of Petroleum Technology, v. 32, no. 12, p. 2132-2138.

Buckley, S.E. and M.C. Leverett, 1942, Mechanisms of Fluid Displacement in Sands: Transactions of Society of Petroleum Engineers of AIME , p. 107-116.

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DOE/BC-86/7/SP, Scientific Software-Intercomp, 1986, Supporting Technology for Enhanced Oil Recovery - In-situ Combustion Predictive Model: Venezuela-MEM/USA-DOE Fossil Energy Report III-3, 263 p.

DOE/BC-86/10/SP, Scientific Software-Intercomp, 1986, Supporting Technology for Enhanced Oil Recovery - Polymer Predictive Model: Venezuela-MEM/USA-DOE Fossil Energy Report III-4, 394 p.

DOE/BC-86/11/SP, Scientific Software-Intercomp, 1986, Supporting Technology for Enhanced Oil Recovery - Chemical Flood Predictive Model: Venezuela-MEM/USA-DOE Fossil Energy Report III-5, 360 p.

DOE/BC-86/12/SP, Scientific Software-Intercomp, 1986, Supporting Technology for Enhanced Oil Recovery - CO_2 Miscible Flood Predictive Model: Venezuela-MEM/USA-DOE Fossil Energy Report III-6, 469 p.

Dykstra, H. and R.L. Parsons, 1950, The Prediction of Oil Recovery by Waterflood in Secondary Recovery of Oil in the United States, 2nd Ed.: American Petroleum Institute, p. 160-174.

Gomaa, E.E., 1980, Correlations for Predicting Oil Recovery by Steamflood: Journal of Petroleum Technology, v. 32, no. 2, p. 325-332.

National Petroleum Council, 1984, Enhanced Oil Recovery: Washington, D.C., 96 p.

Appendix A
STEAM FLOOD PREDICTIVE MODEL
INPUT DATA DESCRIPTION

DETAILS OF RESERVOIR AND ECONOMIC DATA ENTRY ARE GIVEN HERE. A CONDENSED SUMMARY OF THE DATA ENTRY IS GIVEN IN TABLE 2-1.

THREE TYPES OF DATA ARE INDICATED (NO BLANK DATA ALLOWED):

1. "REQUIRED" DATA - PROGRAM WILL NOT RUN UNLESS A VALUE GREATER THAN ZERO IS ENTERED. REQUIRED DATA ARE DEPTH (CARD R6), NET PAY (R6), PERMEABILITY (R7), POROSITY (R7), AND API GRAVITY (R11). SEE TABLE 2-5 FOR ERROR CHECKS.
2. "DEFAULT" DATA - ENTER ZERO TO DEFAULT TO THE VALUE INDICATED. VALUES ENTERED GREATER THAN ZERO ARE USED AS SPECIFIED, UNLESS A MINIMUM OR MAXIMUM VALUE IS INDICATED.
3. "NO DEFAULT" DATA - ANY VALUE ENTERED, INCLUDING ZERO, IS USED AS SPECIFIED.

2.1 RESERVOIR DATA

CARD R1 ***** READ TITLE
READ(IR,) TITLE
MAY BE UP TO 80 ALPHA-NUMERIC CHARACTERS

CARD R2 ***** READ RUN CONTROLS
READ(IR,) IDHT,IWRIS,IWRIT,ISTAB,IHTX,IRES,IPAT,IECON

IDHT - CONTROLS HEAT PRODUCTION FOR IRES = 1 (SURPI ALGORITHM), ALSO USED IN PROJECT LIFE CALCULATION (NO DEFAULT)
= 0, PRODUCED HEAT NOT ACCOUNTED FOR
= 1, PRODUCED HEAT ACCOUNTED FOR USING DATA ON CARD R23

IWRIS - CONTROLS PRINTING OF INTERMEDIATE RESULTS FOR WELLBORE AND SURFACE SYSTEM HEAT LOSS CALCULATIONS (NO DEFAULT, SEE TABLE 2-2 AND SECTION 4.1)
= 0, INTERMEDIATE RESULTS NOT PRINTED
= 1, INTERMEDIATE RESULTS PRINTED FOR SURFACE SYSTEM (WARNING: LENGTHY OUTPUT, MAY PRINT 10,000 LINES)
= 2, INTERMEDIATE RESULTS PRINTED FOR SURFACE AND WELLBORE CALCULATIONS (WARNING: EXTENSIVE OUTPUT, MAY PRINT 20,000 LINES)

IWRIT - CONTROLS PRINTING OF RESULTS OF RESERVOIR CALCULATIONS (NO DEFAULT, SEE TABLE 2-2 AND SECTION 4.1)
= 0, PRINTS ONLY FINAL RESULTS
= 1, ALSO PRINTS FLUID PROPERTIES BY REGION AND PATTERN INJECTION REPORT
= 4, ALSO PRINTS INTERMEDIATE RESULTS FROM GENERATOR CONVERGENCE CALCULATION (WARNING: LENGTHY OUTPUT, MAY PRINT 5,000 LINES)

= 5, ALSO PRINTS INTERMEDIATE RESULTS FROM WELLBORE HEAT TRANSFER COEFFICIENT CALCULATIONS (WARNING: EXTENSIVE OUTPUT, MAY PRINT 25,000 LINES)
= 6, ALSO PRINTS INTERMEDIATE RESULTS FROM SURFACE AND WELLBORE HEAT LOSS CALCULATIONS (WARNING: VOLUMINOUS OUTPUT, MAY PRINT 50,000 LINES)
= 7, ALSO PRINTS EXTENSIVE RESULTS WHEN IRES = 4 (INTERCOMP ALGORITHM), INCLUDING STEAM ZONE AND COLD OIL ZONE SATURATIONS, HEATED BANK SIZES, SWEEP CALCULATIONS, BANK MOBILITIES, RADIAL STEAM OVERLAY, AND FLUIDS AND HEAT-IN-PLACE BY REGION (WARNING: EXTREMELY VOLUMINOUS OUTPUT, MAY PRINT 100,000 LINES)
= 9, ALSO PRINTS REL. PERM. CALCULATIONS BY REGION WHEN IRES = 4 (WARNING: MASSIVE OUTPUT, MAY PRINT 200,000 LINES)

NOTE: TO AVOID VOLUMINOUS OUTPUT, SUGGESTED OUTPUT FORMAT IS IWRIS=0, IWRIT=1 ON THIS CARD, AND IOUT=0,1, OR 2 ON CARD E2

ISTAB - CONTROLS INPUT OF STEAM TABLES (NO DEFAULT)
= 0, USE INTERNAL STEAM TABLES
= 1, USE AND PRINT INTERNAL STEAM TABLES
= 2, READ AND PRINT USER DEFINED STEAM TABLES ON CARDS R3, R4, AND R5

IHTX - CONTROLS CALCULATION METHOD OF SURFACE LINE HEAT LOSS (NO DEFAULT)
= 0, ADIABADIC, NO HEAT LOSS
= 1, USE SPECIFIED COEFFICIENT USURF ON CARD R22
= 2, USE NELSON TABLES (SUBROUTINE QSURF)

IRES - CONTROLS CALCULATION METHOD FOR RESERVOIR PERFORMANCE
= 0, DEFAULTS TO IRES = 3
= 1, SUPRI METHOD
= 2, JONES METHOD
= 3, GOMAA METHOD
= 4, INTERCOMP METHOD

NOTE: FOR SOME DATA A SPECIFIC RECOVERY METHOD (IRES) IS NOTED. IF A RECOVERY METHOD IS BEING IMPLEMENTED WHICH IS DIFFERENT THAN THE ONE NOTED, ENTER ZERO. EXAMPLE: ON CARD R9, IF IRES .NE. 4 (ON CARD R2), ENTER 0.0 FOR SWR(1). USER MAY OF COURSE ENTER 0.0 TO IMPLEMENT DEFAULT FOR SWR(1) WHEN IRES = 4.

IPAT - CONTROLS PATTERN GEOMETRY FOR RESERVOIR PERFORMANCE (SWEEP CALCULATIONS) IF IRES = 4
= 0, DEFAULTS TO IPAT = 5
= 5, FIVE-SPOT GEOMETRY

IECON - CONTROLS ECONOMIC ANALYSIS (NO DEFAULT)
= 0, NO ECONOMIC CALCULATIONS, OMIT CARDS E1 TO E23
= 1, ECONOMIC ANALYSIS, READ CARDS E1 TO E23
= 2, ECONOMIC ANALYSIS AND PLOTS, READ CARDS E1 TO E23

```
CARD R3 ***** READ IN NUMBER OF ENTRIES IN VISCOSITY AND STEAM TABLES
              (READ ONLY IF ISTAB = 2 ON CARD R2)
  READ(IR,) NVT,NST
    NVT    - NUMBER OF ENTRIES IN VISCOSITY TABLE (MAX. 30)
    NST    - NUMBER OF ENTRIES IN STEAM TABLE (MAX. 200)

CARD R4 ***** READ IN STEAM AND WATER VISCOSITY TABLE (READ ONLY IF
              ISTAB = 2 ON CARD R2)
  READ(IR,) TIAB(I),UMUTB(I),UMUTL(I), I=1,NVT
    TIAB(I) - TEMPERATURE, DEG. F
    UMUTB(I)- SATURATED STEAM VISCOSITY, CP
    UMUTL(I)- SATURATED LIQUID WATER VISCOSITY, CP

CARD R5 ***** READ IN STEAM TABLE (READ ONLY IF ISTAB = 2 ON CARD R2)
  READ(IR,) PTAB(I),TTAB(I),SLTAB(I),SGTAB(I),ENTBL(I),ENTBG(I),
            ZENTRL(I),ZENTRG(I),I=1,NST
    PTAB(I)   - STEAM TABLE PRESSURE, PSI
    TTAB(I)   - STEAM TABLE TEMPERATURE, DEG. F
    SLTAB(I)  - LIQUID WATER SPECIFIC VOLUME, CU. FT/LB
    SGTAB(I)  - STEAM SPECIFIC VOLUME, CU. FT/LB
    ENTBL(I)  - LIQUID WATER ENTHALPY, BTU/LB
    ENTBG(I)  - STEAM ENTHALPY, BTU/LB
    ZENTRL(I) - LIQUID WATER ENTROPY, BTU/LB.-DEG. F
    ZENTRG(I) - STEAM ENTROPY, BTU/LB.-DEG. F

CARD R6 ***** READ RESERVOIR DESCRIPTION DATA
  READ(IR,) DEPTH,PFORM,TFORM,TGROSS,TNET
    DEPTH  - RESERVOIR DEPTH, FT (REQUIRED)
    PFORM  - CURRENT RESERVOIR PRESSURE, PSIA (DEFAULT: PFORM = 14.7
             + DEPTH * PGRAD, WHERE PGRAD = 0.433/2. PSI/FT.  THIS PGRAD
             ASSUMES A PARTIALLY DEPLETED RESERVOIR)
    TFORM  - CURRENT RESERVOIR TEMPERATURE, DEG. F  (DEFAULT: TFORM =70.
             + DEPTH * GGRAD, WHERE GGRAD =0.011 DEG. F/FT)
    TGROSS - GROSS THICKNESS OF ZONE, FT (DEFAULT: TGROSS= TNET*1.25)
    TNET   - NET PAY THICKNESS, FT (REQUIRED)

CARD R7 ***** READ RESERVOIR DESCRIPTION DATA
  READ(IR,) PERM,POROS,RHORK,HCAPR,ALPHA
    PERM   - RESERVOIR ABSOLUTE PERMEABILITY, MD (REQUIRED)
    POROS  - RESERVOIR POROSITY, FRACTION (REQUIRED)
    RHORK  - RESERVOIR ROCK DENSITY, LB/CU. FT (DEFAULT = 165.0)
    HCAPR  - RESERVOIR ROCK HEAT CAPACITY, BTU/LB-DEG. F (DEFAULT:
             HCAPR=0.19 + 0.00013*TBAR, WHERE TBAR=(TFORM+TSTM)/2;
             SOMERTON, 1958. TSTM IS STEAM ZONE TEMPERATURE CALCULATED
             INTERNALLY.)
    ALPHA  - RESERVOIR ROCK THERMAL DIFFUSIVITY, SQ. FT/HR
             (DEFAULT = 0.0306; ARBITRARILY CHOSEN)
```

```
CARD R8 ***** READ RESERVOIR DESCRIPTION DATA
  READ(IR,) ACRES,PIINI,EHTI,FTAVG,DIP
    ACRES  - PATTERN AREA, ACRES (DEFAULT: MODEL CALCULATES PATTERN
             AREA (SUBROUTINE LIFET) SUCH THAT PROJECT LIFE IS UNDER 10
             YEARS. MAXIMUM SIZE DEFAULTED IS 80 ACRES, MINIMUM 0.625)
    PIINI  - INITIAL INJECTIVITY INDEX, BPD/PSI (IRES = 1) (DEFAULT: SEE
             SECTION 3.2)
    EHTI   - FRACTION OF AREA HEATED AT HEAT BREAKTHROUGH, FRACTION
             (IRES = 1, NO DEFAULT, MUST BE BETWEEN 0.0 AND 1.0)
    FTAVG  - FRACTION OF STEAM ZONE TEMPERATURE INCREASE APPLIED TO
             HOT LIQUID ZONE TEMPERATURE (IRES = 4, DEFAULT = 0.6)
    DIP    - RESERVOIR DIP, DEGREES (IRES = 3, NO DEFAULT)

CARD R9 ***** READ RESIDUAL SATURATION DATA
        NOTE: RESIDUAL OIL SATN. TO WATER USED IN REGIONS 1,2, AND 3
        AFTER CORRELATION OF ARPS(1956). RESIDUAL OIL SATN. TO STEAM
        USED IN REGION 4 AFTER WILLIAMS, ET AL(1980). RESIDUAL OIL
        SATN. IN ANY REGION IS BOUNDED BY 0.02 AND 1.0. SEE SECTION 3.1
        FOR DEFINITION OF REGIONS(ZONES).
  READ(IR,) SOR(1),SOR(3),SOR(4),SWR(1),SWR(3),SWR(4)
    SOR(1) - RESIDUAL OIL SATURATION IN COLD OIL ZONE, FRACTION
             (IRES = 3 OR 4). DEFAULT FOR REGIONS 1 AND 2: SOR(REGION)=
             (0.3495+0.03657*ALOG(VISO(REGION)))*(1.294-0.0445*
             ALOG(PERM))
    SOR(3) - RESIDUAL OIL SATURATION IN HOT LIQUID ZONE,
             FRACTION (IRES = 4). DEFAULT: SEE SOR(1)
    SOR(4) - RESIDUAL OIL SATURATION IN STEAM ZONE, FRACTION
             (ALL IRES). DEFAULT: SOR(4)=SORX/100.0, WHERE SORX =
             13.253 + 2.5956*ALOG(VISO(4))-0.7196*ALOG(TSTM-TFORM)
    SWR(1) - RESIDUAL WATER SATURATION IN COLD OIL ZONE, FRACTION
             (IRES = 4). DEFAULT = 0.20
    SWR(3) - RESIDUAL WATER SATURATION IN HOT LIQUID ZONE,
             FRACTION (IRES = 4). DEFAULT FOR REGIONS 3 AND 4:
             SWR(REGION)=SWR(1)+SWR(1)*0.00245)*(T(REGION)-TFORM)
    SWR(4) - RESIDUAL WATER SATURATION IN STEAM ZONE, FRACTION
             (IRES = 4). DEFAULT: SEE SWR(3)

CARD R10 ***** READ INITIAL CONDITION DATA
  READ(IR,) SOI,SGI,SWI,SST,RS
    SOI    - CURRENT OIL SATURATION IN RESERVOIR, FRACTION
             (DEFAULT: SOI = 1.-SWI-SGI)
    SGI    - CURRENT GAS SATURATION IN RESERVOIR, FRACTION (DEFAULT=0.0)
    SWI    - CURRENT WATER SATURATION IN RESERVOIR, FRACTION
             (DEFAULT = SWR(1))
    SST    - MINIMUM STEAM SATURATION IN STEAM ZONE, FRACTION
             (DEFAULT=0.5; FAROUQ ALI, 1970)
    RS     - CURRENT SOLUTION GAS/OIL RATIO, SCF/STB
             (DEFAULT: SEE SECTION 3.2)
```

```
CARD R11 ***** READ FLUID DENSITY DATA
  READ(IR,) API,SGW,SGG, RHO1,RHO4
    API     - OIL GRAVITY, DEG. API (REQUIRED)
    SGW     - WATER SPECIFIC GRAVITY (W.R.T. WATER), FRACTION
              (DEFAULT = 1.0)
    SGG     - GAS SPECIFIC GRAVITY (W.R.T. AIR), FRACTION (DEFAULT= 0.8)
    RHO1    - OIL DENSITY IN COLD RESERVOIR, LB/CU. FT
              DEFAULT: RHO(REGION)=62.4*SGO/BO(REGION), SEE SECTION 3.2
              FOR CALCULATION OF BO(REGION). SGO IS OIL SP. GR.
              CALCULATED INTERNALLY FROM API GRAVITY.
    RHO4    - OIL DENSITY AT STEAMFLOOD CONDITIONS, LB/CU. FT
              (DEFAULT: SEE RHO1)

CARD R12 ***** READ FLUID DATA
  READ(IR,) HCAPO,HCAPW,VIS1,VIS4
    HCAPO   - HEAT CAPACITY OF OIL, BTU/LB-DEG. F
              (DEFAULT: HCAPO = 0.000557*TSTM+0.00267*API*0.333;
              FRICK, 1962)
    HCAPW   - HEAT CAPACITY OF WATER, BTU/LB-DEG. F
              (DEFAULT: HCAPW = (ENTHALPY STEAM ZONE-ENTHALPY ORIG.
              WATER)/(TSTM-TFORM))
    VIS1    - OIL VISCOSITY IN COLD RESERVOIR, CP, ALSO = VISO(1)
              (DEFAULT: SEE SECTION 3.2)
    VIS4    - OIL VISCOSITY AT STEAMFLOOD CONDITIONS, CP, ALSO = VISO(4)
              (DEFAULT: SEE SECTION 3.2)

CARD R13 ***** READ RELATIVE PERMEABILITY DATA
         (IRES = 4, SEE TABLE 2-3 FOR KR RELATIONSHIPS)
  READ(IR,) KRWROI,KRWROT,KROCWI,KROCWT,KRGROI,KRGROT
    KRWROI - INITIAL ENDPOINT OF KRW CURVE, FRACTION (DEFAULT = 0.2)
    KRWROT - CHANGE IN ENDPOINT OF KRW CURVE WITH TEMP, 1/DEG. F
             (DEFAULT = 0.00215)
    KROCWI - INITIAL ENDPOINT OF KRO CURVE, FRACTION (DEFAULT = 1.0)
    KROCWT - CHANGE IN ENDPOINT OF KRO CURVE WITH TEMP, 1/DEG.F
             (NO DEFAULT)
    KRGROI - INITIAL ENDPOINT OF KRG CURVE, FRACTION (DEFAULT = 1.0)
    KRGROT - CHANGE IN ENDPOINT OF KRG CURVE WITH TEMP, 1/DEG. F
             (NO DEFAULT)

CARD R14 ***** READ RELATIVE PERMEABILITY DATA
         (IRES = 4, SEE TABLE 2-3 FOR KR RELATIONSHIPS)
  READ(IR,) NWI,NWP,NOW,NOG,NG
    NWI     - INITIAL EXPONENT OF KRW EQUATION (DEFAULT = 2.0)
    NWP     - CHANGE IN EXPONENT OF KRW EQUATION WITH FRACTIONAL CHANGE
              IN PRESSURE (NO DEFAULT)
    NOW     - EXPONENT OF KRO EQUATION FOR OIL/WATER SYSTEM
              (DEFAULT = 2.0)
    NOG     - EXPONENT OF KRO EQUATION FOR OIL/GAS SYSTEM
              (DEFAULT = 2.0)
    NG      - EXPONENT OF KRG EQUATION (DEFAULT = 2.0)
```

```
CARD R15 ***** READ SURFACE SYSTEM AND WELLBORE DATA
  READ(IR,) NWELL,IUTYP,NSURF,ITYPE,IPSUR
    NWELL  - NUMBER OF INCREMENTS IN WELLBORE (MAX. 20).
             ENTER ZERO TO DISABLE WELLBORE HEAT LOSS CALCULATIONS
    IUTYP  - CONTROL FOR TYPE OF INSULATION ON WELLBORE TUBING STRING
             FOR CALCULATION OF OVERALL HEAT TRANSFER COEFFICIENT
             (FIG. 3 OF WILLHITE, 1967)
             = 0, SET TO 1.0 BTU/(HR - SQ.FT - DEG.F)
             = 1, 1" COMMERCIAL INSULATION
             = 2, ALUMINUM PAINT
             = 3, MILL SCALE, ANNULUS PRESSURE = 0 PSIG
             = 4, MILL SCALE, ANNULUS PRESSURE = 1000 PSIG
             = 5, MILL SCALE, ANNULUS PRESSURE = 2500 PSIG
    NSURF  - NUMBER OF INCREMENTS IN SURFACE PIPE (MAX.20). ENTER
             ZERO TO DISABLE SURFACE PIPE HEAT LOSS CALCULATIONS.
             NOTE: IF NO WELLBORE CALCS., THEN THE SURFACE HEAT LOSS
             CALC. ALSO SKIPPED.
    ITYPE  - CONTROL FOR TYPE OF INSULATION ON SURFACE PIPE FOR
             CALCULATION OF HEAT LOSS USING NELSON TABLES (USED ONLY IF
             IHTX = 2 ON CARD R2)
             = 0, DEFAULT TO ITYPE = 1
             = 1, BARE PIPE (200 DEG. F TO 600 DEG. F ONLY)
             = 2, 1 AND 1/2" MAGNESIA INSULATION (200 DEG. F TO 800
                  DEG. F ONLY)
    IPSUR  - CONTROL FOR WIND SPEED AND AMBIENT TEMPERATURE FOR
             CALCULATION OF HEAT LOSS THROUGH SURFACE PIPE USING
             NELSON TABLES (USED ONLY IF IHTX = 2 ON CARD R2)
             = 0, DEFAULTS TO IPSUR = 1
             = 1, STILL AIR, 0 DEG. F
             = 2, STILL AIR, 100 DEG. F
             = 3, 10 M.P.H. WIND, 0 DEG. F
             = 4, 10 M.P.H. WIND, 100 DEG. F
             = 5, 40 M.P.H. WIND, 0 DEG. F
             = 6, 40 M.P.H. WIND, 100 DEG. F

*** SKIP TO CARD R23 IF NWELL .EQ. 0 ON CARD R15 ***

CARD R16 ***** READ WELLBORE LENGTH INCREMENTS
         (READ ONLY IF NWELL .GT. 0 ON CARD R15)
  READ(IR,) (DELZ(IZ),IZ=1,NWELL)
    DELZ(IZ) - LENGTH OF WELLBORE INCREMENT, FT
               (DEFAULT: DELZ(IZ) = DEPTH/NWELL)

CARD R17 ***** READ SURFACE PIPE LENGTH INCREMENTS
         (READ ONLY IF NSURF .GT. 0 ON CARD R15)
  READ(IR,) (DELS(I),I=1,NSURF)
    DELS(I) - LENGTH OF SURFACE PIPE INCREMENT, FT
              (DEFAULT: DELS(I) = 500.0/NSURF
```

```
CARD R18 ***** READ WELLBORE CONDUCTIVITY DATA
         (READ ONLY IF NWELL .GT. 0 ON CARD R15)
  READ(IR,) AKCEM,AKE,AKHA,AKINS,XCOEF
    AKCEM  - THERMAL CONDUCTIVITY OF CEMENT, BTU/HR-FT-DEG.F
             (DEFAULT = 0.50)
    AKE    - THERMAL CONDUCTIVITY OF EXTERNAL RESERVOIR ROCK,
             BTU/HR-FT-DEG.F (DEFAULT = 1.0)
    AKHA   - THERMAL CONDUCTIVITY OF ANNULUS FLUID, BTU/HR-FT-DEG.F
             (DEFAULT = 0.1)
    AKINS  - THERMAL CONDUCTIVITY OF TUBING INSULATION,
             BTU/HR-FT-DEG.F (DEFAULT = 0.04)
    XCOEF  - OVERRIDE HEAT TRANSFER COEFFICIENT FOR THE WELLBORE
             (REPLACES WILLHITE CALCULATION), BTU/HR-SQ.FT-DEG.F
             (DEFAULT: WILLHITE CALCULATION, SUBROUTINE HTRX,
             SEE SECTION 1.4)

CARD R19 ***** READ WELLBORE EMISSIVITY DATA
         (READ ONLY IF NWELL .GT. 0 ON CARD R15)
  READ(IR,) EPSTO,EPSCI,UTOL
    EPSTO  - OUTER TUBING EMISSIVITY FOR RADIANT HEAT FLUX,
             DIMENSIONLESS (DEFAULT = 0.9)
    EPSCI  - INNER TUBING EMISSIVITY FOR RADIANT HEAT FLUX,
             DIMENSIONLESS (DEFAULT = 0.4)
    UTOL   - CONVERGENCE TOLERANCE FOR WILLHITE OVERALL HEAT TRANSFER
             COEFFICIENT CALCULATION, FRACTION (DEFAULT = 0.01)

CARD R20 ***** READ WELLBORE GEOMETRY DATA
         (READ ONLY IF NWELL .GT. 0 ON CARD R15)
  READ(IR,) RH,RCO,RCI,RINS,RTO,RTI,EPSR
         (NOTE: WELLBORE DEFAULTS ASSUME 7 IN. CASING AND 2-7/8 IN.
         TUBING WITHOUT INSULATION)
    RH   - HOLE RADIUS (OUTSIDE OF CEMENT, ALSO RW), FT
           (DEFAULT: RW = 0.25; RH = RCI * 1.4)
    RCO  - OUTER CASING RADIUS, FT (DEFAULT: RCO = RCI + 0.026)
    RCI  - INNER CASING RADIUS, FT (DEFAULT = 0.2655)
    RINS - RADIUS TO OUTSIDE OF INSULATION, FT (DEFAULT = RTO)
    RTO  - OUTER TUBING.RADIUS, FT (DEFAULT = RTI + 0.015, BUT IF
           RTO .GT. RCI, RTO = RCI)
    RTI  - INNER TUBING RADIUS, FT (DEFAULT = 0.102, BUT IF RTI .GT.
           RTO, RTI = RTO)
    EPSR - ROUGHNESS OF WELLBORE PIPE, INCHES (DEFAULT = 0.0008)

CARD R21 *****  READ ANNULUS PROPERTIES AND TEMPERATURE
         (READ ONLY IF NWELL .GT. 0 ON CARD R15)
  READ(IR,) RHOAN,UMUAN,CAN,TEANN,GGRAD
    RHOAN  - DENSITY OF ANNULAR FLUID, LB/CU. FT (DEFAULT = 0.10)
    UMUAN  - VISCOSITY OF ANNULAR FLUID, CP (DEFAULT = 0.05)
    CAN    - HEAT CAPACITY OF ANNULAR FLUID, BTU/LB-DEG. F
             (DEFAULT = 0.20)
    TEANN  - TEMPERATURE OF ANNULAR FLUID, DEG. F (DEFAULT = TSTM)
```

```
    GGRAD  - GEOTHERMAL GRADIENT, DEG. F/FT
             DEFAULTS: IF TFORM (CARD R6) .EQ. 0.0, GGRAD = .011;
             IF TFORM .GT. 0.0, GGRAD = (TFORM-TGRG(1))/DEPTH

*** SKIP TO CARD R23 IF NSURF .EQ. 0 ON CARD R15 ***

CARD R22 *****  READ SURFACE SYSTEM DATA
         (READ ONLY IF NWELL .GT. 0 AND NSURF .GT. 0 ON CARD R15)
  READ(IR,) RSURI,EPSC,USURF,TGRG(1),BEAND,DELPC
    RSURI  - SURFACE PIPE RADIUS, FT (DEFAULT = RTI)
    EPSC   - ROUGHNESS OF SURFACE PIPE, INCHES (DEFAULT =0.0008)
    USURF  - OVERALL HEAT TRANSFER COEFFICIENT FOR SURFACE PIPE,
             BTU/HR-SQ.FT-DEG.F, USED IF IHTX = 1 ON CARD R2
             (DEFAULT = 0.5)
    TGRG(1)- GROUND TEMPERATURE AT SURFACE, DEG. F (DEFAULT = 70.0)
    BEAND  - BEAN DIAMETER, INCHES (DEFAULT = 0.75)
    DELPC  - CHOKE PRESSURE DROP, PSI (NO DEFAULT)
             = 0, NO PRESSURE DROP CALCULATED
             > 0, THIS PRESSURE DROP USED DIRECTLY
             < 0, SONIC FLOW ASSUMED, PRESSURE REDUCED BY HALF ACROSS
                  CHOKE

CARD R23 ***** READ CASE DATA
  READ(IR,) HTPR,E11,TIMAX,ECO,OVERI
    HTPR   - HEAT PRODUCED PER FOOT OF PAY (USED TO CALCULATE PROJECT
             LIFE), MMBTU/FT OF FORMATION (DEFAULT: HTPR = 992.2 -
             1060.9 * E11 * E11 +0.006276 * QQ * QQ, WHERE QQ = WI *
             (X(N)*DIFEN+DIFFT)/(DIFEN + DIFFT), WHERE DIFEN = ENTHALPY
             VAPOR(N) - ENTHALPY LIQUID(N), DIFFT = T(N)- TFORM, AND
             N IS AT BOTTOMHOLE STEAM CONDITIONS.
    E11    - ESTIMATED EFFICIENCY (FRACTION OF AREA HEATED) AT END OF
             PROJECT (USED IN SUPRI CALCULATIONS), FRACTION (DEFAULT:
             E11=(0.01)*(-237.43-11.279*ALOG(VISO(1)/VISO(4))-0.47331*
             DIFFT+90.167*ALOG(DIFFT)). E11 BOUNDED BY 0.4 AND 0.9.
    TIMAX  - MAXIMUM PATTERN LIFE, DAYS (DEFAULT = 20. * 365., MAY NOT
             EXCEED 50. * 365.)
    ECO    - MINIMUM OIL RATE FOR PATTERN, STB/DAY (NO DEFAULT,
             MUST BE > 0)
    OVERI  - MULTIPLIER OF CALCULATED STEAM OVERLAY ANGLE (IRES = 4),
             FRACTION (NO DEFAULT)
             = 0, NO MODIFICATION (SAME AS = 1.0)
             < 0, NO OVERLAY CALCULATED
             > 0, MULTIPLICATIVE MODIFICATION, WITH THIS VALUE, OF ANGLE
                  CALCULATED BY SUPRI LIFETIME CALCULATION, MMBTU/FT

CARD R24 ***** READ TIME STEP DATA
         (REPEAT THIS CARD UNTIL PROJECT DEFINED. IF NTS DEFAULTED, GO
         DIRECTLY TO CARD R25. IF NTS NOT DEFAULTED, ENTER A CARD WITH
         5 ZEROS, THEN GO TO CARD R25)
  READ(IR,) NTS,TIMINC,WI,PGENS,XQUAL
    NTS    - NUMBER OF TIME STEPS TAKEN WITH DATA ON THIS CARD
             (DEFAULT: NTS(1)= TIMAX/TIMINC(1)) NOTE: SUM OF NTS ON ALL
```

```
    TIMINC - SIZE OF TIME STEP TO BE TAKEN, DAYS
             (DEFAULT: TIMINC(1) = TIMAX/59.959)
    WI     - STEAM INJECTION RATE FOR TIME STEP, BPD(CWE)
             DEFAULTS: IF PIINI (CARD R8) .LE. 0.0, WI(1)= 1.5*TNET*
                       ACRES, WI BOUNDED BY 350.0 AND 2000.0.
                       IF PIINI .GT. 0.0, WI(1) = PIINI *(PFRAC-PFORM),
                       WHERE PFRAC = 0.5 *DEPTH.
    PGENS  - MAXIMUM GENERATOR PRESSURE FOR TIME STEP, PSIA
             DEFAULTS: IF(PGENS(1) .LE. 0.0) PGENS(1) = PFORM+100.0
                       IF(PGENS(1) .LE. 101.) PGENS(1) = DEPTH * 0.5
                       IF(PGENS(1) .GT. 2000.0) PGENS(1) = 2000.0
    XQUAL  - STEAM QUALITY FOR TIME STEP, MASS FRACTION:
              AT SANDFACE IF NWELL = 0 ON CARD R15
               (DEFAULT: XQUAL(1) = 0.7 -6.E-5*DEPTH; CURVE OF
               ZOLOTUKHIN, 1979)
              AT WELLHEAD IF NWELL > 0 AND NSURF = 0 (DEFAULT = 0.8)
              AT GENERATOR IF NWELL > 0 AND NSURF > 0 (DEFAULT = 0.8)

CARD R25 ***** END CARD (READ ONLY IF IECON = 0 ON CARD R2)
  READ (IR,) END
    END - "END" IN COLUMNS 1-4
```

2.2 ECONOMIC DATA

```
THE FOLLOWING CARDS ARE TO BE READ IF IECON =1 ON CARD R2.

CARD E1 ***** READ TITLE
  READ(IR,) TITLE
    MAY BE UP TO 80 ALPHA-NUMERIC CHARACTERS

CARD E2 ***** READ CASE CONTROLS
  READ(IR,) M,ISTATE,IDIST,IOUT,IFIT,IDAT,NCT,NCI,IDISC,IFUL,
            ISO,IDEBT
    M      - NUMBER OF YEARS IN THE PROJECT (FOR ALL PATTERNS)
             M MUST BE .LE. 50
    ISTATE - STATE CODE. USED TO DEFAULT WELL CAPITAL COSTS
             (DRILLING, COMPLETION, CONVERSION, UPGRADING)
             BY REGION OF U.S. SEE SECTION 3.3 FOR EXPLANATION OF
             OF DEFAULTS BY REGION. TO INVOKE DEFAULTS FOR WELL
             CAPITAL COSTS, ENTER THE APPROPRIATE NUMBER 1-52 FROM THE
             TABLE BELOW, AND WPP'S AS REQUIRED ON CARD E7.
```

CODE	ALPHA	STATE	CODE	ALPHA	STATE
1	AL	ALABAMA	27	NV	NEVADA
2	AZ	ARIZONA	28	NH	NEW HAMPSHIRE
3	AR	ARKANSAS	29	NJ	NEW JERSEY
4	CA	CALIFORNIA	30	NM	NEW MEXICO
5	CO	COLORADO	31	NY	NEW YORK
6	CT	CONNECTICUT	32	NC	N.CAROLINA
7	DE	DELAWARE	33	ND	N.DAKOTA
8	DC	WASH D.C.	34	OH	OHIO
9	FL	FLORIDA	35	OK	OKLAHOMA
10	GA	GEORGIA	36	OR	OREGON
11	ID	IDAHO	37	PA	PENNSYLVANIA
12	IL	ILLINOIS	38	RI	RHODE ISLAND
13	IN	INDIANA	39	SC	S.CAROLINA
14	IA	IOWA	40	SD	S.DAKOTA
15	KS	KANSAS	41	TN	TENNESSEE
16	KY	KENTUCKY	42	TX	TEXAS
17	LA	LOUISIANA	43	UT	UTAH
18	ME	MAINE	44	VT	VERMONT
19	MD	MARYLAND	45	VA	VIRGINIA
20	MA	MASS	46	WA	WASHINGTON
21	MI	MICHIGAN	47	WV	WEST VIRGINIA
22	MN	MINNESOTA	48	WI	WISCONSIN
23	MS	MISSISSIPPI	49	WY	WYOMING
24	MO	MISSOURI	50	AK	ALASKA
25	MT	MONTANA	51	HI	HAWAII
26	NE	NEBRASKA	52	PO	OFFSHORE

TO DISABLE DEFAULTS FOR WELL COSTS, ENTER WPP1=WPP2=WPP3=WPP4=0.0 ON CARD E7. THEN WELL COSTS MAY, IF DESIRED, BE ENTERED AS PART OF CAPITAL COSTS ON CARDS E21-E22. IF WPP'S=0.0 ON CARD E7 AND ISTATE = 1-52 ON THIS CARD, THEN MODEL PENALIZES OIL PRICE BASED ON API GRAVITY AND LOCATION. SEE SECTION 3.3 FOR EXPLANATION OF PENALITIES. IF PROJECT IS OUTSIDE U.S. OR IT IS DESIRED TO DISABLE OIL PRICE PENALTY, ENTER WPP'S = 0.0 ON CARD E7 AND ISTATE = 53 ON THIS CARD. NOTE: IF ISTATE = 53 SELECTED, USER MUST ENTER WPP'S = 0.0 ON CARD E7.

IDIST - DISTRICT CODE (WITHIN A STATE). USED TO DEFAULT WELL COSTS. SEE SECTION 3.3 FOR DEFAULTS. IF OUTSIDE U.S. OR IF ISTATE= 53, ENTER IDIST=0. FOR TEXAS RAILROAD COMMISSION (RRC) DISTRICTS, ENTER (RRC NO. * 10) + Y, WHERE

Y = 1 FOR A
= 2 FOR B
= 3 FOR C

EG., FOR DISTRICT 10B ENTER 102, ETC.

```
     IOUT   - CONTROLS PRINTING OF RESULTS OF ECONOMIC CALCULATIONS
              (NO DEFAULT, SEE TABLE 2-2)
              = 0, MINIMUM OUTPUT GIVING RESULTS ONLY
              = 1, ALSO PRINTS ANNUAL CASH FLOW TABLE, PROJECT SCHEDULE,
                   AND UNDISCOUNTED RESULTS
              = 2, ALSO PRINTS PROJECT RESULTS AND DCFROR
                   INTERMEDIATE RESULTS
     IFIT   - FEDERAL INCOME TAX CREDIT OPTION (NO DEFAULT)
              = 0, ALLOWS A TAX CREDIT TO OFFSET LOSSES
              = 1, NO TAX CREDIT ALLOWED
     IDAT   - CONTROL FOR READING PRICE AND COST DATA
              = 0, DEFAULT PRICES AND COSTS USED, SKIP CARDS E15-E20;
                   SEE E15-E20 FOR DEFAULT VALUES
              = 1, READ CARDS E15-E20 FOR PRICE AND COST DATA
     NCT    - CONTROL FOR READING TANGIBILE CAPITAL INVESTMENT PER
              PATTERN IN ANY GIVEN YEAR. INVESTMENTS WILL BE TIMED
              ACCORDING TO PATTERN SCHEDULE ON CARD E13.
              = 0, DO NOT READ TANGIBLE CAPITAL INVESTMENT ON CARD E21
              = 1, READ TANGIBLE CAPITAL INVESTMENT ON CARD E21
     NCI    - CONTROL FOR READING INTANGIBLE CAPITAL INVESTMENT PER
              PATTERN IN ANY GIVEN YEAR. INVESTMENTS WILL BE TIMED
              ACCORDING TO PATTERN SCHEDULE ON CARD E13.
              = 0, DO NOT READ INTANGIBLE CAPITAL INVESTMENT ON CARD E22
              = 1, READ INTANGIBLE CAPITAL INVESTMENT ON CARD E22
     IDISC  - CONTROL FOR DISCOUNTING METHOD (NO DEFAULT)
              = 0, YEAR END DISCOUNTING FACTORS USED
              = 1, MID-YEAR DISCOUNTING FACTORS USED
     IFUL   - GENERATOR FUEL CONTROL (NO DEFAULT, SEE CARD E17)
              = 0, PURCHASED FUEL USED (GAS)
              = 1, PRODUCED LEASE CRUDE USED
     ISO    - CONTROL FOR READING SECONDARY OIL VOLUMES (NO DEFAULT)
              = 0, DO NOT READ SECONDARY OIL VOLUMES
              = 1, READ SECONDARY OIL VOLUMES ON CARD E11
     IDEBT  - CONTROL ON DEBT CALCULATIONS (NO DEFAULT)
              = 0, NO CAPITAL BORROWING DEBT CALCULATIONS
              = 1, INCLUDE CAPITAL BORROWING DEBT BASED ON DATA INPUT
                   ON CARD E3

CARD E3 ***** READ DEBT CONTROLS (READ IF IDEBT = 1 ON CARD E2)
  READ(IR,) PCTDBT,DBTINT,NYRRPY,NYPAID
     PCTDBT - PERCENT OF CAPITAL (TANGIBLE AND INTANGIBLE) COSTS
              TO BE BORROWED, PERCENT. (DEFAULT=20.)
     DBTINT - DEBT INTEREST RATE, PERCENT (DEFAULT=15.)
     NYRRPY - NUMBER OF YEARS BEFORE BEGINNING DEBT REPAYMENT
              (DEFAULT=1.)
     NYPAID - NUMBER OF YEARS BEFORE COMPLETING DEBT REPAYMENT
              (DEFAULT=5.)
```

```
CARD E4 ***** READ GENERATOR DATA
  READ(IR,) GCOST,GCAP,GLIFE,GRAT,GEFF,PEFF
    GCOST - GENERATOR COST, M$ (DEFAULT = 800.0, BASED ON 50 MMBTU UNIT)
    GCAP  - GENERATOR THROUGHPUT CAPACITY, BPD(CWE)
            DEFAULTS: IF (GCAP.EQ.0.) GCAP = 3000.0
                      IF (GCAP.LT.0.) GCAP = 0.0
    GLIFE - GENERATOR LIFE, YEARS (DEFAULT = 99.0)
    GRAT  - GENERATOR FUEL RATING (100% EFFICIENCY), BTU/UNIT OF FUEL.
            DEFAULTS: IF(GRAT.LE.0. .AND. IFUL.LE.0.) GRAT=1.E6 BTU/MCF
                      IF(GRAT.LE.0. .AND. IFUL.GE.1.) GRAT=6.3E6 BTU/STB
    GEFF  - GENERATOR EFFICIENCY, FRACTION (DEFAULT = 0.85)
    PEFF  - FRACTION OF PRODUCED HEAT REUTILIZED, FRACTION (NO DEFAULT)

CARD E5 ***** READ GENERATOR SCHEDULE (READ ONLY IF GCAP .LT. 0. ON
        CARD E4). THIS OPTION USED TO SPECIFY PARTIAL (OR TO ELIMINATE)
        GENERATOR CAPITAL COSTS. NO CHECK IS MADE ON GENERATOR CAPACITY.
  READ(IR,) GNUM(I), I=1,MYR
    GNUM - NUMBER OF GENERATORS PURCHASED EACH OF MYR YEARS

CARD E6 ***** READ OPERATING DATA
  READ(IR,) WOCOST,WTCOST,WCAP,COSTRT,UNCO
    WOCOST - ANNUAL WELL WORKOVER COST PER PATTERN, M$
             DEFAULT= 0.25*CNVT. ASSUMES ONE WORKOVER PER PATTERN
             EVERY FOUR YEARS. CNVT IS THE COST TO CONVERT AN
             EXISTING PRODUCER TO AN INJECTION WELL. SEE SECTION 3.3
             FOR DEFAULT FOR CNVT.
    WTCOST - PRODUCED WATER TREATING COST, $/BBL (DEFAULT= 0.125)
    WCAP   - MONTHS OF WORKING CAPITAL, MONTHS (NO DEFAULT)
    COSTRT - PROJECT STARTUP COSTS, M$ (NO DEFAULT)
    UNCO   - OIL RATE UNCERTAINTY, FRACTION (DEFAULT = 0.001)

CARD E7 ***** READ DRILLING DATA
  READ(IR,) WPP1,WPP2,WPP3,WPP4
            (ENTER ALL ZEROS IF WELL CAPITAL COSTS INCLUDED ON CARDS
            E21-E22. SEE SECTION 3.3 FOR WELL CAPITAL COSTS DEFAULT
            EQUATIONS USING WPP'S.)
    WPP1 - NUMBER OF INJECTORS DRILLED PER PATTERN (NO DEFAULT)
    WPP2 - NUMBER OF PRODUCERS DRILLED PER PATTERN (NO DEFAULT)
    WPP3 - NUMBER OF PRIMARY PRODUCERS CONVERTED TO SECONDARY PRODUCERS
           PER PATTERN (NO DEFAULT)
    WPP4 - NUMBER OF EXISTING PRODUCERS CONVERTED TO INJECTORS
           PER PATTERN (NO DEFAULT)

CARD E8 ***** READ TAXES AND MONETARY DATA
  READ(IR,) XDR,XINF,XROY,XSEV,XFIT,XTCR,DTIM,XSTX
    XDR  - MONETARY DISCOUNT RATE (DEFAULT = 0.10)
    XINF - INFLATION RATE (NO DEFAULT)
    XROY - ROYALTY RATE (NO DEFAULT)
    XSEV - SEVERANCE TAX RATE (NO DEFAULT)
    XFIT - FEDERAL INCOME TAX RATE (NO DEFAULT)
```

```
    XTCR - INVESTMENT TAX CREDIT (NO DEFAULT)
    DTIM - INVESTMENT DEPRECIATION TIME, YRS (NO DEFAULT)
           IF DTIM = 0.0, MODEL USES ACCELERATED CAPITAL RECOVERY SYSTEM
           (5 YEAR DEPRECIATION) ACCORDING TO 1981 TAX ACT (SEE
           TABLE 2-4). IF DTIM .GT. 0.0, USES STRAIGHT LINE DEPRECIATION
           FROM YEAR OF INVESTMENT OVER DTIM YEARS.
    XSTX - STATE INCOME TAX RATE (NO DEFAULT)

CARD E9 ***** READ WINDFALL (PROFIT) EXCISE TAX DATA
  READ(IR,) XWPT,WPHO,EPHO,BTIM,BPOW
    XWPT - WINDFALL EXCISE TAX RATE. IF 0.0 THEN IGNORES TAX.
           SEE SECTION 3.3 FOR EXPLANATION OF WINDFALL EXCISE TAX.
    WPHO - WINDFALL TAX BEGINNING PHASE OUT DATE (DEFAULT 1991.)
    EPHO - WINDFALL TAX ENDING PHASE OUT DATE (DEFAULT 1993.)
    BTIM - BASE TIME FOR PROJECT START (DEFAULT 1985.)
    BPOW - BASE OIL PRICE AT START OF PROJECT FOR WPT CALCULATIONS
           ONLY, $/BBL (DEFAULT= 23.07*(1.+XINF)**(BTIM-1983.)
           NOTE: OIL PRICE FOR SALES AND REVENUE PURPOSES IS ENTERED OR
           DEFAULTED ON CARD E15)

CARD E10 ***** READ SECONDARY OIL PRODUCTION DATA
         (USED TO COMPUTE OIL RELEASED FROM WPT)
  READ(IR,) OILB,OILC,DECL
    OILB - 1979 PROJECT BASE OIL RATE, MBBL/YR (DEFAULT = 0.0)
    OILC - CURRENT NON-TERTIARY PROJECT OIL RATE, MBBL/YR
           (DEFAULT = OILB*(1.-DECL)**(BTIM-1979.))
    DECL - ANNUAL OIL PRODUCTION DECLINE RATE, PERCENT (DEFAULT = 15.)

CARD E11 ***** READ SECONDARY OIL PRODUCTION CURVE
         (READ ONLY IF ISO = 1 ON CARD E2, USED TO COMPUTE OIL RELEASED
         FROM WPT)
  READ(IR,) (VOS(I),I=1,M)
    VOS(I) - VOLUME OF SECONDARY OIL PER PATTERN EACH YEAR, MB/YR.
             (NPTE: IF ISO = 0, MODEL DEFAULTS
             VOS(I) = OILC*(1.-DECL)**FLOAT(I)-0.5; TO OBTAIN VOS(I)=0,
             SET OILB = 0 ON CARD E10)

CARD E12 ***** READ ESCALATION DATA
  READ(IR,) ESCPO,ESCPG,ESCPF,ESCFO,ESCGC,ESCCT,ESCCI,ESCWO
    ESCPO - ESCALATION RATE OF OIL PRICE (NO DEFAULT)
    ESCPG - ESCALATION RATE OF GAS PRICE (NO DEFAULT)
    ESCPF - ESCALATION RATE OF FUEL PRICE (NO DEFAULT)
    ESCFO - ESCALATION RATE OF OPERATING COSTS (NO DEFAULT)
    ESCGC - ESCALATION RATE OF GENERATOR COSTS (NO DEFAULT)
    ESCCT - ESCALATION RATE OF TANGIBLE CAPITAL (NO DEFAULT)
    ESCCI - ESCALATION RATE OF INTANGIBLE CAPITAL (NO DEFAULT)
    ESCWO - ESCALATION RATE OF WELL WORKOVER COST (NO DEFAULT)

CARD E13 ***** READ PROJECT PATTERN SCHEDULE
  READ(IR,) (PATI(I),I=1,M)
    PATI(I) - NUMBER OF PATTERNS INITIATED EACH YEAR OF THE PROJECT
```

```
CARD E14 ***** READ CAPITAL INVESTMENT DATA
         IF DEFAULTING CAPITAL COSTS FOR WELLS (NCT=NCI=0 ON CARD E2 AND
         WPP1+WPP2+WPP3+WPP4.NE.0.0 ON CARD E7), THEN OTHER CAPITAL
         COSTS ENTERED ON THIS CARD WILL BE ROLLED-UP WITH WELL COSTS TO
         GIVE TOTAL CAPITAL. HOWEVER, IF CAPITAL COSTS ARE READ IN ON
         CARDS E21-E22 (NCT=NCI=1 ON CARD E2), THEN ONLY GENERATOR COSTS
         (GCOST, CARD E4) WILL BE INCLUDED IN CAPITAL ROLL-UP, AND $ FOR
         CTACRE, ETC. ON THIS CARD SHOULD BE INCLUDED IN CAPITAL
         INVESTMENTS ENTERED ON CARDS E21-E22.
  READ (IR,) CTACRE,CWRP,CPFP,DCE
    CTACRE - CAPITAL FOR SURFACE FACILITIES, INCLUDING STEAM MANIFOLDS
             AND FLOWLINES, AND SURFACE PRODUCTION/VAPOR RECOVERY LINES,
             $/ACRE (DEFAULT = 21750.)
    CWRP   - CAPITAL FOR WATER RECYCLE PLANT, $/BWPD (DEFAULT = 75.)
    CPFP   - CAPITAL FOR OIL PRODUCTION FACILITIES, $/BOPD
             (DEFAULT = 400.)
    DCE    - WELL DRILLING, COMPLETION, EQUIPMENT COSTS, $/FOOT
             (DEFAULT = 100.0) NOTE: IF WPP1=WPP2=0.0 ON CARD E7,
             DCE NOT USED

-----------------------------------------------------------------------
IF IDAT=0 ON CARD E2, MODEL USES DEFAULT PRICES AND COSTS: SKIP TO
CARD E21
-----------------------------------------------------------------------

     IN ALL OF THE FOLLOWING ARRAYS, THE LAST LETTER (H, M, OR L)
 MEANS HIGH, MOST LIKELY, OR LOW VALUE OF THE PARAMETER IN A
 GIVEN YEAR.  THE HIGH AND LOW VALUES SHOULD BE CHOSEN TO
 REPRESENT A CONFIDENCE LEVEL OF 80 PERCENT.  LOW PRICE HAS A 90%
 CHANCE OF BEING OBTAINED, AND THE HIGH PRICE HAS ONLY A 10%
 CHANCE OF BEING REACHED. SEE SECTION 1.9 FOR DISCUSSION OF RISK.

     PRICES AND COSTS, WHETHER ENTERED OR DEFAULTED, ARE SCALED BY
 PROGRAM (SUBROUTINE ECFTR) DUE TO VARIATION IN OIL PRICE FROM
 $30.00/BBL. THE PRICE FACTOR IS FACT=(POM(1)-30.00)/30., WHERE
 POM(1) IS ENTERED OR DEFAULTED ON CARD E15.  THEN:

         DRILLING AND COMPLETION FACTOR = 1.0 +(0.4 * FACT)
         EQUIPMENT FACTOR = 1.0 +(0.3 * FACT)
         OPERATING COSTS FACTOR = 1.0 +(0.2 * FACT)
         FUEL FACTOR = 1.0 + (1.0 * FACT)
         OIL PRICE FACTOR = 1.0 + FACT

CARD E15 ***** READ OIL PRICE DATA
         (NOTE: SEE SECTION 3.3 FOR REDUCTION OF READ IN (OR DEFAULTED)
         OIL PRICE BASED ON API GRAVITY AND LOCATION)
  READ(IR,) POL(1),POM(1),POH(1)
    POL(1) - LOW OIL PRICE, $/BBL (DEFAULT= POM(1) * 0.8)
    POM(1) - MOST LIKELY OIL PRICE, $/BBL (DEFAULT= 30.00)
    POH(1) - HIGH OIL PRICE, $/BBL (DEFAULT = POM(1) *1.2)
```

```
CARD E16 ***** READ GAS PRICE DATA
  READ(IR,) PGL(1),PGM(1),PGH(1)
    PGL(1) - LOW GAS PRICE, $/MSCF (DEFAULT = PGM(1) * 0.8)
    PGM(1) - MOST LIKELY GAS PRICE, $/MSCF
             (DEFAULT: PGM(1) = 4.42 * (1.0 +((POM(1)-30.00)/30.00))
    PGH(1) - HIGH GAS PRICE, $/MSCF (DEFAULT = PGM(1) * 1.2)

CARD E17 ***** READ FUEL PRICE DATA
         (IF IFUL = 1 (CARD E2), THE FUEL IS LEASE CRUDE AND THE FUEL
         COST IS THE SELLING PRICE OF OIL. IF IFUL = 0, THEN GAS IS USED
         AS FUEL, DEFAULTED TO GAS PRICE)
  READ(IR,) PFL(1),PFM(1),PFH(1)
    PFL(1) - LOW FUEL PRICE, $/UNIT OF FUEL
             DEFAULT: IF (IFUL.EQ.0) PFL(1)=PGL(1)
                      IF (IFUL.EQ.1) PFL(1)=POL(1)
    PFM(1) - MOST LIKELY FUEL PRICE, $/UNIT OF FUEL
             DEFAULT: IF (IFUL.EQ.0) PFM(1)=PGM(1)
                      IF (IFUL.EQ.1) PFM(1)=POM(1)
    PFH(1) - HIGH FUEL PRICE, $/UNIT OF FUEL
             DEFAULT: IF (IFUL.EQ.0) PFH(1)=PGH(1)
                      IF (IFUL.EQ.1) PFH(1)=POH(1)

CARD E18 ***** READ FIXED ANNUAL OPERATING COST DATA
         (INCLUDES MAINTENANCE, OTHER COSTS THAT DO NOT DEPEND ON OIL
         RATE)
  READ(IR,) FOCL(1),FOCM(1),FOCH(1)
    FOCL(1) - LOW FIXED  OPERATING COST PER PATTERN, $/YR
              (DEFAULT = 16000.)
    FOCM(1) - MOST LIKELY FIXED OPERATING COST PER PATTERN, $/YR
              (DEFAULT = 18000.)
    FOCH(1) - HIGH FIXED OPERATING COST PER PATTERN, $/YR
              (DEFAULT = 20000.)

CARD E19 ***** READ VARIABLE ANNUAL OPERATING COST DATA
         (INCLUDES LIFTING AND OTHER COSTS THAT DEPEND ON OIL PRODUCTION
         DIRECTLY, BUT NOT ROYALTY OR SEVERANCE)
  READ(IR,) OPCL(1),OPCM(1),OPCH(1)
    OPCL(1) - LOW VARIABLE OPERATING COSTS, $/STB OIL PRODUCED
              (DEFAULT = 2.00)
    OPCM(1) - MOST LIKELY VARIABLE OPERATING COSTS, $/STB OIL PRODUCED
              (DEFAULT = 2.50)
    OPCH(1) - HIGH VARIABLE OPERATING COSTS, $/STB OIL PRODUCED
              (DEFAULT = 3.00)

CARD E20 ***** READ STEAM GENERATOR OPERATING COST DATA
         (COST OF WATER TREATING, SCRUBBING, AND GENERAL MAINTENANCE)
  READ(IR,) GCPL(1),GCPM(1),GCPH(1)
    GCPL(1) - LOW GENERATOR OPERATING COST, $/BBL(CWE) STEAM INJECTED
              (DEFAULT = 0.30)
```

```
    GCPM(1) - MOST LIKELY GENERATOR OPERATING COST, $/BBL(CWE) STEAM
              INJECTED (DEFAULT = 0.36)
    GCPH(1) - HIGH GENERATOR OPERATING COST, $/BBL(CWE) STEAM INJECTED
              (DEFAULT = 0.42)

CARD E21 ***** READ TANGIBLE CAPITAL INVESTMENT (READ IF NCT=1 ON CARD
         E2). FLOW LINES, WELLS, ROADS, AND PRODUCTION FACILITIES,
         BUT NOT GENERATORS. IF WELLS ENTERED ON CARD E7, DO NOT
         ENTER WELL CAPITAL COSTS ON THIS CARD.
  READ(IR,) ICT,CTPL,CTPM,CTPH
    ICT  - ENTER 1.0
    CTPL - LOW TANGIBLE CAPITAL COST PER PATTERN, $
    CTPM - MOST LIKELY TANGIBLE CAPITAL COST PER PATTERN, $
    CTPH - HIGH TANGIBLE CAPITAL COST PER PATTERN, $

CARD E22 ***** READ INTANGIBLE CAPITAL INVESTMENT (READ IF NCI=1 ON CARD
         E2). CAPITAL EXPENSED IN A GIVEN YEAR.  IF WELLS ENTERED ON
         CARD E7, DO NOT ENTER WELL CAPITAL COSTS ON THIS CARD.
  READ(IR,) ICI,CIPL,CIPM,CIPH
    ICI  - ENTER 1.0
    CIPL - LOW INTANGIBLE CAPITAL COST PER PATTERN, $
    CIPM - MOST LIKELY INTANGIBLE CAPITAL COST PER PATTERN, $
    CIPH - HIGH INTANGIBLE CAPITAL COST PER PATTERN, $

CARD E23 ***** END CARD
  READ (IR,) END
    END - "END" IN COLUMNS 1-4

********** RETURN TO CARD R1 FOR NEW CASE ***********
```

TABLE 2-1
SFPM DATA ENTRY

Reservoir Data

R1 TITLE
R2 IDHT, IWRIS, IWRIT, ISTAB, IHTX, IRES, IPAT, IECON
R3 NVT, NST(ENTER IF ISTAB=2)
R4 TIAB(I), UMUTB(I), UMUTL(I), I=1, NVT(ENTER IF ISTAB=2)
R5 PTAB(I), TTAB(I), SLTAB(I), SGTAB(I), ENTBL(I), ENTBG(I), ZENTRL(I), ZENTRG(I), I=1, NST(ENTER IF ISTAB=2)
R6 DEPTH, PFORM, TFORM, TGROSS, TNET
R7 PERM, POROS, RHORK, HCAPR, ALPHA
R8 ACRES, PIINI, EHTI, FTAVG, DIP
R9 SOR(1), SOR(3), SOR(4), SWR(1), SWR(3), SWR(4)
R10 SOI, SGI, SWI, SST, RS
R11 API, SGW, SGG, RHO1, RHO4
R12 HCAPO, HCAPW, VIS1, VIS4
R13 KRWROI, KRWROT, KROCWI, KROCWT, KRGROI, KRGROT
R14 NWI, NWP, NOW, NOG, NG
R15 NWELL, IUTYP, NSURF, ITYPE, IPSUR
*** SKIP TO R23 IF NWELL=0 ***
R16 DELZ(IZ), IZ=1, NWELL
R17 DELS(I), I=1, NSURF
R18 AKCEM, AKE, AKHA, AKINS, XCOEF
R19 EPSTO, EPSCI, UTOL
R20 RH, RCO, RCI, RINS, RTO, RTI, EPSR
R21 RHOAN, UMUAN, CAN, TEANN, GGRAD
*** SKIP TO R23 IF NSURF=0 ***
R22 RSURI, EPSC, USURF, TGRG(1), BEND, DELPC
R23 HTPR, E11, TIMAX, ECO, OVERI
R24 NTS, TIMINC, WI, PGENS, XQUAL
R25 END (ENTER IF IECON=0)

Economic Data

E1 TITLE
E2 M, ISTATE, IDIST, IOUT, IFIT, IDAT, NCT, NCI, IDISC, IFUL, ISO, IDEBT
E3 PCTDBT, DBTINT, NYRRPY, NYPAID (ENTER IF IDEBT=1)
E4 GCOST, GCAP, GLIFE, GRAT, GEFF, PEFF

TABLE 2-1 Cont.

```
E5  GNUM(I), I=1, MYR (ENTER IF GCAP<0)
E6  WOCOST, WTCOST, WCAP, COSTRT, UNCO
E7  WPP1, WPP2, WPP3, WPP4
E8  XDR, XINF, XROY, XSEV, XFIT, XTCR, DTIM, XSTX
E9  XWPT, WPHO, EPHO, BTIM, BPOW
E10 OILB, OILC, DECL
E11 VOS(I), I=1, M (ENTER IF ISO=1)
E12 ESCPO, ESCPG, ESCPF, ESCFO, ESCGC, ESCCT, ESCCI, ESCWO
E13 PAT(I), I=1,M
E14 CTACRE, CWRP, CPFP, DCE
*** SKIP TO E21 IF 1DAT=0 ***
E15 POL(1), POM(1), POH(1)
E16 PGL(1), PGM(1), PGH(1)
E17 PFL(1), PFM(1), PFH(1)
E18 FOCL(1), FOCM(1), FOCH(1)
E19 OPCL(1), OPCM(1), OPCH(1)
E20 GCPL(1), GCPM(1), GCPH(1)
E21 ICT, CTPL, CTPM, CTPH (ENTER IF NCI=1)
E22 ICI, CIPL, CIPM, CIPH (ENTER IF NCT=1)
E23 END
```

Appendix B
IN-SITU COMBUSTION PREDICTIVE MODEL
INPUT DATA DESCRIPTION

DETAILS OF RESERVOIR AND ECONOMIC DATA ENTRY ARE GIVEN HERE. A CONDENSED SUMMARY OF THE DATA ENTRY IS GIVEN IN TABLE 2-1.

THREE TYPES OF DATA ARE INDICATED (NO BLANK DATA ALLOWED):

1. "REQUIRED" DATA - PROGRAM WILL NOT RUN UNLESS A VALUE GREATER THAN ZERO IS ENTERED.
2. "DEFAULT" DATA - IF ZERO IS ENTERED, DATA DEFAULTS TO THE VALUE INDICATED. VALUES GREATER THAN ZERO ARE USED AS SPECIFIED, UNLESS A MINIMUM VALUE IS INDICATED.
3. "NO DEFAULT" DATA - ANY VALUE ENTERED, INCLUDING ZERO, IS USED AS SPECIFIED.

2.1 RESERVOIR DATA

CARD R1 ***** TITLE
READ(IR,) TITLE
MAY BE UP TO 80 ALPHA-NUMERIC CHARACTERS

CARD R2 ***** RUN CONTROLS
READ(IR,) IRES, IPAT, IWRIT, IECON
IRES - ENTER ZERO
IPAT - ENTER ZERO
IWRIT - CONTROLS PRINTING OF RESULTS OF RESERVOIR CALCULATIONS (NO DEFAULT, SEE TABLE 2-2)
= 0, PRINTS ONLY FINAL RESULTS
= 1, ALSO PRINTS CUMULATIVES
IECON - CONTROLS ECONOMIC ANALYSIS (NO DEFAULT)
= 0, NO ECONOMIC CALCULATIONS,OMIT CARDS E1 TO E20
= 1, ECONOMIC ANALYSIS, READ CARDS E1 TO E20
= 2, ECONOMIC ANALYSIS AND PLOTS, READ CARDS E1 TO E20

CARD R3 ***** RESERVOIR DESCRIPTION DATA
READ(IR,) DEPTH, PFORM, TFORM
DEPTH - RESERVOIR DEPTH, FT (REQUIRED)
PFORM - RESERVOIR PRESSURE, PSIA (DEFAULT: PFORM=14.7+DEPTH*PGRAD, WHERE PGRAD=0.433/2.0 PSI/FT)
TFORM - RESERVOIR TEMPERATURE, DEG. F. VALUE ENTERED MUST BE .GE. 60. (DEFAULT: TFORM=70.0+DEPTH*GGRAD, WHERE GGRAD=0.011 DEG.F/FT)

```
CARD R4 ***** RESERVOIR DESCRIPTION DATA
  READ(IR,) TNET, PERM, POROS
    TNET   - TOTAL NET PAY THICKNESS, FT (REQUIRED)
    PERM   - RESERVOIR ABSOLUTE PERMEABILITY, MD (REQUIRED)
    POROS  - RESERVOIR POROSITY, FRACTION (REQUIRED)

CARD R5 ***** INITIAL CONDITION DATA
  READ(IR,) SOI, SGI, SWI
    SOI    - CURRENT OIL SATURATION IN RESERVOIR, FRACTION (REQUIRED)
    SGI    - CURRENT GAS SATURATION IN RESERVOIR, FRACTION
             (ENTER 0.0, GAS SATURATION NOT USED)
    SWI    - CURRENT WATER SATURATION IN RESERVOIR, FRACTION (REQUIRED)

CARD R6 ***** FLUID DATA
  READ(IR,) API, VISO, BOI, BWI
    API    - OIL GRAVITY, DEG.API (REQUIRED)
    VISO   - DEAD OIL VISCOSITY, CP (DEFAULT: SEE SECTION 3)
    BOI    - OIL FORMATION VOLUME FACTOR, RB/STB
             (DEFAULT: SEE SECTION 3)
    BWI    - WATER FORMATION VOLUME FACTOR, RB/STB
             (DEFAULT: SEE SECTION 3)

CARD R7 ***** CASE DATA
  READ(IR,) AREA, WELLSP, ARIN, FWA, SWEEP ,BRNMX
    AREA   - TOTAL DEVELOPED AREA, ACRES (REQUIRED)
    WELLSP - NUMBER OF PRODUCING WELLS IN DEVELOPED AREA (REQUIRED)
             NOTE: MODEL CALCULATES PATTERN AREA= AREA/WELLSP/2. ,
             WHERE NUMBER OF INJECTION WELLS = WELLSP/2.
    ARIN   - AIR INJECTION RATE, MSCF/D (DEFAULT: SEE SECTION 3)
    FWA    - WATER/AIR RATIO, STB/MSCF
           = -1.0, FOR DEFAULT: IF PERM .GE. 100. AND VISO .GE. 10.,
             WET COMBUSTION USED TO CALCULATE AIR REQUIREMENT,
             OTHERWISE DRY COMBUSTION USED
           =  0.0, FOR DRY COMBUSTION
           =  1.0, FOR WET COMBUSTION
    SWEEP  - MAXIMUM VOLUME SWEPT, FRACTION
             IF 0.0, THEN DEFAULT BASED ON PATTERN AREA AS FOLLOWS:
           = 0.40, FOR AREA .GE. 20. ACRES
           = 0.50, FOR 5.0 .LE. AREA .LT. 20. ACRES
           = 0.60, FOR AREA .LT. 5.0 ACRES

    BRNMX  - MAXIMUM THICKNESS PER BURN ZONE, FT
           = 0,  DEFAULTS TO 150. FT FOR EACH BURN ZONE
           > 0,  EQUALS THICKNESS OF EACH ZONE IN FT
           < 0,  DISABLES OPTION, AND ONE BURN ZONE
                 OF THICKNESS = TNET WILL BE USED

CARD R8 ***** END CARD (READ ONLY IF IECON = 0 ON CARD R2)
  READ (IR,) END
    END - "END" IN COLUMNS 1-4
```

2.2 ECONOMIC DATA

THE FOLLOWING CARDS ARE TO BE READ IF IECON =1 ON CARD R2.

CARD E1 ***** TITLE
  READ(IR,) TITLE
    MAY BE UP TO 80 ALPHA-NUMERIC CHARACTERS

CARD E2 ***** CASE CONTROLS
  READ(IR,) M,ISTATE,IDIST,IOUT,IFIT,IDAT,NCT,NCI,IDISC,
            ISO,IDEBT
    M - NUMBER OF YEARS IN THE PROJECT (FOR ALL PATTERNS)
        M MUST BE .LE. 50
    ISTATE - STATE CODE. USED TO DEFAULT WELL CAPITAL COSTS
        (DRILLING, COMPLETION, CONVERSION, UPGRADING)
        BY REGION OF U.S. SEE SECTION 3 FOR EXPLANATION OF
        OF DEFAULTS BY REGION. TO INVOKE DEFAULTS FOR WELL
        CAPITAL COSTS, ENTER THE APPROPRIATE NUMBER 1-52 FROM THE
        TABLE BELOW, AND WPP'S AS REQUIRED ON CARD E7.

CODE	ALPHA	STATE	CODE	ALPHA	STATE
1	AL	ALABAMA	27	NV	NEVADA
2	AZ	ARIZONA	28	NH	NEW HAMPSHIRE
3	AR	ARKANSAS	29	NJ	NEW JERSEY
4	CA	CALIFORNIA	30	NM	NEW MEXICO
5	CO	COLORADO	31	NY	NEW YORK
6	CT	CONNECTICUT	32	NC	N.CAROLINA
7	DE	DELAWARE	33	ND	N.DAKOTA
8	DC	WASH D.C.	34	OH	OHIO
9	FL	FLORIDA	35	OK	OKLAHOMA
10	GA	GEORGIA	36	OR	OREGON
11	ID	IDAHO	37	PA	PENNSYLVANIA
12	IL	ILLINOIS	38	RI	RHODE ISLAND
13	IN	INDIANA	39	SC	S.CAROLINA
14	IA	IOWA	40	SD	S.DAKOTA
15	KS	KANSAS	41	TN	TENNESSEE
16	KY	KENTUCKY	42	TX	TEXAS
17	LA	LOUISIANA	43	UT	UTAH
18	ME	MAINE	44	VT	VERMONT
19	MD	MARYLAND	45	VA	VIRGINIA
20	MA	MASS	46	WA	WASHINGTON
21	MI	MICHIGAN	47	WV	WEST VIRGINIA
22	MN	MINNESOTA	48	WI	WISCONSIN
23	MS	MISSISSIPPI	49	WY	WYOMING
24	MO	MISSOURI	50	AK	ALASKA
25	MT	MONTANA	51	HI	HAWAII
26	NE	NEBRASKA	52	PO	OFFSHORE

TO DISABLE DEFAULTS FOR WELL COSTS, ENTER WPP1=WPP2=WPP3=
WPP4=0.0 ON CARD E7. THEN WELL COSTS MAY, IF DESIRED,
BE ENTERED AS PART OF CAPITAL COSTS ON CARDS E18-E19. IF
WPP'S=0.0 ON CARD E7 AND ISTATE = 1-52 ON THIS CARD, THEN
MODEL PENALIZES OIL PRICE BASED ON API GRAVITY AND
LOCATION. SEE SECTION 3 FOR EXPLANATION OF PENALITIES.
IF PROJECT IS OUTSIDE U.S. OR IT IS DESIRED TO DISABLE OIL
PRICE PENALTY, ENTER WPP'S = 0.0 ON CARD E7 AND ISTATE = 53
ON THIS CARD. NOTE: IF ISTATE = 53 SELECTED, USER MUST
ENTER WPP'S = 0.0 ON CARD E7.

IDIST - DISTRICT CODE (WITHIN A STATE). USED TO DEFAULT WELL COSTS.
SEE SECTION 3 FOR DEFAULTS. IF OUTSIDE U.S. OR IF
ISTATE= 53, ENTER IDIST=0. FOR TEXAS RAILROAD COMMISSION
(RRC) DISTRICTS, ENTER (RRC NO. * 10) + Y, WHERE

Y = 1 FOR A
= 2 FOR B
= 3 FOR C

EG., FOR DISTRICT 10B ENTER 102, ETC.

IOUT - INTERMEDIATE OUTPUT CONTROL (NO DEFAULT, SEE TABLE 2-2)
= 0, MINIMUM OUTPUT GIVING RESULTS ONLY
= 1, PLUS ANNUAL CASH FLOW, PROJECT SCHEDULE, AND
UNDISCOUNTED RESULTS
= 2, PLUS PROJECT MEAN RESULTS AND "DCFROR"
INTERMEDIATE RESULTS

IFIT - FEDERAL INCOME TAX CREDIT OPTION (NO DEFAULT)
= 0, ALLOWS A TAX CREDIT TO OFFSET LOSSES
= 1, NO TAX CREDIT ALLOWED

IDAT - CONTROL FOR READING PRICE AND COST DATA
= 0, DEFAULT PRICES AND COSTS USED, SKIP CARDS E14-E17;
SEE E14-E17 FOR DEFAULT VALUES
= 1, READ CARDS E14-E17 FOR PRICE AND COST DATA

NCT - CONTROL FOR READING TANGIBILE CAPITAL INVESTMENT PER
PATTERN IN ANY GIVEN YEAR. INVESTMENTS WILL BE TIMED
ACCORDING TO PATTERN SCHEDULE ON CARD E13.
= 0, DO NOT READ TANGIBLE CAPITAL INVESTMENT ON CARD E18
= 1, READ TANGIBLE CAPITAL INVESTMENT ON CARD E18

NCI - CONTROL FOR READING INTANGIBLE CAPITAL INVESTMENT PER
PATTERN IN ANY GIVEN YEAR. INVESTMENTS WILL BE TIMED
ACCORDING TO PATTERN SCHEDULE ON CARD E13.
= 0, DO NOT READ INTANGIBLE CAPITAL INVESTMENT ON CARD E19
= 1, READ INTANGIBLE CAPITAL INVESTMENT ON CARD E19

IDISC - CONTROL FOR DISCOUNTING METHOD (NO DEFAULT)
= 0, YEAR END DISCOUNTING FACTORS USED
= 1, MID-YEAR DISCOUNTING FACTORS USED

```
    ISO    - CONTROL FOR READING SECONDARY OIL VOLUMES (NO DEFAULT)
             = 0, DO NOT READ SECONDARY OIL VOLUMES
             = 1, READ SECONDARY OIL VOLUMES ON CARD E11
    IDEBT  - CONTROL ON DEBT CALCULATIONS (NO DEFAULT)
             = 0, NO CAPITAL BORROWING DEBT CALCULATIONS
             = 1, INCLUDE CAPITAL BORROWING BASED ON DATA INPUT
                  ON CARD E3

CARD E3 ***** DEBT CONTROLS (READ IF IDEBT = 1 ON CARD E2)
  READ(IR,) PCTDBT,DBTINT,NYRRPY,NYPAID
    PCTDBT - PERCENT OF CAPITAL (TANGIBLE AND INTANGIBLE) COSTS
             TO BE BORROWED, PERCENT (DEFAULT=20.)
    DBTINT - DEBT INTEREST RATE, PERCENT (DEFAULT=15.)
    NYRRPY - FIRST YEAR OF DEBT REPAYMENT (DEFAULT=1.)
    NYPAID - LAST YEAR OF DEBT REPAYMENT (DEFAULT=5.)

CARD E4 ***** CAPITAL COST DATA
        IF DEFAULTING CAPITAL COSTS FOR WELLS (NCT=NCI=0 ON CARD E2 AND
        WPP1+WPP2+WPP3+WPP4.NE.0.0 ON CARD E7), THEN OTHER CAPITAL COSTS
        ENTERED ON THIS CARD WILL BE ROLLED-UP WITH WELL COSTS TO GIVE
        TOTAL CAPITAL. HOWEVER, IF CAPITAL COSTS ARE READ IN ON CARDS
        E18-E19 (NCT=NCI=1 ON CARD E2), THEN ONLY COMPRESSOR COSTS
        (CCOST) FROM THIS CARD WILL BE INCLUDED IN CAPITAL ROLL-UP, AND
        $ FOR GTRT, WTRT, ETC. SHOULD BE INCLUDED IN CAPITAL INVESTMENTS
        ENTERED ON CARDS E18-E19.
  READ(IR,) CCOST, GTRT, WTRT, CTACR, DCE, PLANT
    CCOST  - COMPRESSOR COST, $/HP (DEFAULT= 1000.)
    GTRT   - WASTE GAS TREATING COST, $/MSCF/D (DEFAULT= 50.)
    WTRT   - WATER TREATING AND RECYCLE COST, $/BBL/D (DEFAULT= 75.)
    CTACR  - AIR DISTRIBUTION, VAPOR RECOVERY, AND
             SURFACE FACILITIES COST, $/ACRE (DEFAULT= 26500.)
    DCE    - WELL DRILLING/COMPLETION/EQUIP COST, $/FOOT (DEFAULT=100.)
             NOTE: IF WPP1=WPP2=0.0 ON CARD E7, DCE NOT USED
    PLANT  - CENTRAL PLANT FACILITIES COST, $/STB/D (DEFAULT= 500.)

CARD E5 ***** OPERATING COST DATA
  READ(IR,) WOCOST, WTCOST, WDCOST, COSTML, COSTTI
    WOCOST - ANNUAL WELL WORKOVER COST PER PATTERN, M$
             (DEFAULT= 0.25*CNVT). ASSUMES ONE WORKOVER PER PATTERN
             EVERY FOUR YEARS. CNVT IS THE COST TO CONVERT AN
             EXISTING PRODUCER TO AN INJECTION WELL. SEE SECTION 3
             FOR DEFAULT FOR CNVT.
    WTCOST - PRODUCED WATER TREATING COST, $/BBL (DEFAULT= 0.125)
    WDCOST - WATER DISPOSAL COST, $/BBL (DEFAULT= 0.10)
    COSTML - COMPRESSOR MAINT AND LABOR COST, $/MSCF (DEFAULT= 0.03)
    COSTTI - TECHNICIAN AND INSTRUMENT COST, $/MSCF (DEFAULT= 0.04)
```

```
CARD E6 ***** OPERATING DATA
  READ(IR,) WCAP, COSTRT, UNCO
    WCAP   - MONTHS OF WORKING CAPITAL, MONTHS (NO DEFAULT)
    COSTRT - PROJECT STARTUP COSTS, M$ (NO DEFAULT; THE NEGATIVE OF
             COSTRT WILL BE USED TO INITIALIZE CASH FLOW)
    UNCO   - OIL RATE UNCERTAINTY, FRACTION (DEFAULT= 0.001)

CARD E7 ***** DRILLING DATA
  READ(IR,) WPP1,WPP2,WPP3,WPP4
            (ENTER ALL ZEROS IF WELL CAPITAL COSTS INCLUDED ON CARDS
            E18-E19. SEE SECTION 3 FOR WELL CAPITAL COSTS DEFAULT
            EQUATIONS USING WPP'S.)
    WPP1 - NUMBER OF INJECTORS DRILLED PER PATTERN (NO DEFAULT)
    WPP2 - NUMBER OF PRODUCERS DRILLED PER PATTERN (NO DEFAULT)
    WPP3 - NUMBER OF PRIMARY PRODUCERS CONVERTED TO SECONDARY PRODUCERS
           PER PATTERN (NO DEFAULT)
    WPP4 - NUMBER OF EXISTING PRODUCERS CONVERTED TO INJECTORS
           PER PATTERN (NO DEFAULT)

CARD E8 ***** TAXES AND MONETARY DATA
  READ(IR,) XDR,XINF,XROY,XSEV,XFIT,XTCR,DTIM,XSTX
    XDR  - MONETARY DISCOUNT RATE (DEFAULT= 0.1)
    XINF - INFLATION RATE (NO DEFAULT)
    XROY - ROYALTY RATE (NO DEFAULT)
    XSEV - SEVERANCE TAX RATE (NO DEFAULT)
    XFIT - FEDERAL INCOME TAX RATE (NO DEFAULT)
    XTCR - INVESTMENT TAX CREDIT (NO DEFAULT)
    DTIM - INVESTMENT DEPRECIATION TIME, YRS (NO DEFAULT)
           IF DTIM = 0.0, USES ACCELERATED CAPITAL RECOVERY SYSTEM
           (5 YEAR DEPRECIATION) ACCORDING TO 1981 TAX ACT (SEE TABLE
           2-3). IF DTIM .GT. 0.0, USES STRAIGHT LINE DEPRECIATION FROM
           YEAR OF INVESTMENT OVER DTIM YEARS.
    XSTX - STATE INCOME TAX RATE (NO DEFAULT)

CARD E9 ***** WINDFALL EXCISE TAX DATA
  READ(IR,) XWPT,WPHO,EPHO,BTIM,BPOW
    XWPT - WINDFALL EXCISE TAX RATE. IF 0.0 THEN IGNORES TAX.
           SEE SECTION 3 FOR EXPLANATION OF WINDFALL EXCISE TAX.
    WPHO - WINDFALL TAX BEGINNING PHASE OUT DATE (DEFAULT= 1991.)
    EPHO - WINDFALL TAX ENDING PHASE OUT DATE (DEFAULT= 1993.)
    BTIM - BASE TIME FOR PROJECT START (DEFAULT= 1985.)
    BPOW - BASE OIL PRICE AT START OF PROJECT FOR WPT CALCULATIONS
           ONLY, $/BBL (DEFAULT= 23.07*(1.+XINF)**(BTIM-1983.)
           NOTE: OIL PRICE FOR SALES AND REVENUE PURPOSES IS ENTERED OR
           DEFAULTED ON CARD E14)
```

```
CARD E10 ***** SECONDARY OIL PRODUCTION DATA
  READ(IR,) OILB,OILC,DECL
    OILB - 1979 PROJECT BASE OIL RATE, MBBL/YR (DEFAULT = 0.)
    OILC - CURRENT NON-TERTIARY PROJECT OIL RATE, MBBL/YR
           (DEFAULT = OILB * (1.-DECL)**(BTIM-1979.))
    DECL - ANNUAL OIL PRODUCTION DECLINE RATE, PERCENT (DEFAULT = 15.)

CARD E11 ***** SECONDARY OIL PRODUCTION CURVE
         (READ IF ISO = 1 ON CARD E2)
  READ(IR,) (VOS(I),I=1,M)
    VOS(I) - VOLUME OF SECONDARY OIL PER PATTERN EACH YEAR, MBBL/YR
             (DEFAULT = OILC * (1.-DECL)**(FLOAT(I)-0.5))

CARD E12 ***** ESCALATION DATA FOR PRICES AND COSTS
  READ(IR,) ESCPO,ESCFO,ESCED,ESCCT,ESCCI,ESCWO
    ESCPO - ESCALATION RATE OF OIL PRICE (NO DEFAULT)
    ESCFO - ESCALATION RATE OF OPERATING COSTS (NO DEFAULT)
    ESCED - ESCALATION RATE OF ELEC. DRIVER COSTS (NO DEFAULT)
    ESCCT - ESCALATION RATE OF TANGIBLE CAPITAL (NO DEFAULT)
    ESCCI - ESCALATION RATE OF INTANGIBLE CAPITAL (NO DEFAULT)
    ESCWO - ESCALATION RATE OF WELL WORKOVER COST (NO DEFAULT)

CARD E13 ***** PROJECT PATTERN SCHEDULE
  READ(IR,) (PATI(I),I=1,M)
    PATI(I) - NUMBER OF PATTERNS INITIATED EACH YEAR OF THE PROJECT
              (NO DEFAULT)

-----------------------------------------------------------------------
IF IDAT=0 ON CARD E2, MODEL USES DEFAULT PRICES AND COSTS; SKIP TO
CARD E18
-----------------------------------------------------------------------
```

IN ALL OF THE FOLLOWING ARRAYS, THE LAST LETTER (H, M, OR L) MEANS HIGH, MOST LIKELY, OR LOW VALUE OF THE PARAMETER IN A GIVEN YEAR. THE HIGH AND LOW VALUES SHOULD BE CHOSEN TO REPRESENT A CONFIDENCE LEVEL OF 80 PERCENT. LOW PRICE HAS A 90% CHANCE OF BEING OBTAINED, AND THE HIGH PRICE HAS ONLY A 10% CHANCE OF BEING REACHED.

PRICES AND COSTS, WHETHER ENTERED OR DEFAULTED, ARE SCALED BY PROGRAM (SUBROUTINE ECFTR) DUE TO VARIATION IN OIL PRICE FROM $30.00/BBL. THE PRICE FACTOR IS FACT=(POM(1)-30.00)/30., WHERE POM(1) IS ENTERED OR DEFAULTED ON CARD E14. THEN:

DRILLING AND COMPLETION FACTOR = 1.0 +(0.4 * FACT)
EQUIPMENT FACTOR = 1.0 +(0.3 * FACT)
OPERATING COSTS FACTOR = 1.0 +(0.2 * FACT)
OIL PRICE FACTOR = 1.0 + FACT

```
 THESE FACTORS ARE ALSO USED TO ALTER VALUES ENTERED OR DEFAULTED ON
 CARDS E4 AND E5.

CARD E14 ***** OIL PRICE DATA
          (NOTE: SEE SECTION 3 FOR OIL PRICE REDUCTION BASED ON API
          GRAVITY AND TRANSPORATION PENALTY FOR ALASKA)
  READ(IR,) POL(1),POM(1),POH(1)
    POL(1) - LOW OIL PRICE, $/BBL (DEFAULT= POM(1) * 0.8)
    POM(1) - MOST LIKELY OIL PRICE, $/BBL (DEFAULT= 30.00)
    POH(1) - HIGH OIL PRICE, $/BBL (DEFAULT = POM(1) *1.2)

CARD E15 ***** FIXED ANNUAL OPERATING COST DATA
          (INCLUDES MAINTENANCE, OTHER COSTS THAT DO NOT DEPEND ON OIL
          RATE)
  READ(IR,) FOCL(1),FOCM(1),FOCH(1)
    FOCL(1) - LOW FIXED OPERATING COST PER PATTERN, $/YR
              (DEFAULT= 18000.)
    FOCM(1) - MOST LIKELY FIXED OPERATING COST PER PATTERN, $/YR
              (DEFAULT= 20000.)
    FOCH(1) - HIGH FIXED OPERATING COST PER PATTERN, $/YR
              (DEFAULT= 22000.)

CARD E16 ***** VARIABLE ANNUAL OPERATING COST DATA
          (INCLUDES LIFTING AND OTHER COSTS THAT DEPEND ON OIL PRODUCTION
           DIRECTLY, BUT NOT ROYALTY OR SEVERANCE)
  READ(IR,) OPCL(1),OPCM(1),OPCH(1)
    OPCL(1) - LOW VARIABLE OPERATING COST, $/BBL OIL PRODUCED
              (DEFAULT= 2.50)
    OPCM(1) - MOST LIKELY VARIABLE OPERATING COST, $/BBL OIL PRODUCED
              (DEFAULT= 3.00)
    OPCH(1) - HIGH VARIABLE OPERATING COST, $/BBL OIL PRODUCED
              (DEFAULT= 3.50)

CARD E17 ***** ELECTRIC DRIVER OPERATING COST DATA
          (COST BASED ON 95% DRIVE EFFICIENCY AND $0.07/KWHR)
  READ(IR,) EDPL(1),EDPM(1),EDPH(1)
    EDPL(1) - LOW DRIVER OPERATING COST, $/KWHR (DEFAULT= 0.05)
    EDPM(1) - MOST LIKELY DRIVER OPERATING COST, $/KWHR (DEFAULT= 0.07)
    EDPH(1) - HIGH DRIVER OPERATING COST, $/KWHR (DEFAULT= 0.09)

CARD E18 ***** TANGIBLE CAPITAL INVESTMENT (READ IF NCT=1 ON CARD E2)
          (FLOW LINES, WELLS, ROADS, AND PRODUCTION FACILITIES,
          BUT NOT COMPRESSORS). IF WELLS ENTERED ON CARD E7, DO NOT
          ENTER WELL CAPITAL COSTS ON THIS CARD.
  READ(IR,) ICT,CTPL,CTPM,CTPH
    ICT  - ENTER 1.0
    CTPL - LOW TANGIBLE CAPITAL COST PER PATTERN, $
    CTPM - MOST LIKELY TANGIBLE CAPITAL COST PER PATTERN, $
    CTPH - HIGH TANGIBLE CAPITAL COST PER PATTERN, $
```

```
CARD E19 ***** INTANGIBLE CAPITAL INVESTMENT (READ IF NCI=1 ON CARD E2)
         (CAPITAL EXPENSED IN A GIVEN YEAR).  IF WELLS ENTERED ON
         CARD E7, DO NOT ENTER WELL CAPITAL COSTS ON THIS CARD.
  READ(IR,) ICI,CIPL,CIPM,CIPH
    ICI  - ENTER 1.0
    CIPL - LOW INTANGIBLE CAPITAL COST PER PATTERN, $
    CIPM - MOST LIKELY INTANGIBLE CAPITAL COST PER PATTERN, $
    CIPH - HIGH INTANGIBLE CAPITAL COST PER PATTERN, $

CARD E20 ***** END CARD
  READ (IR,) END
    END - "END" IN COLUMNS 1-4

********** RETURN TO CARD R1 FOR NEW CASE ***********
```

TABLE 2-1
QUICK REFERENCE TO ICPM DATA ENTRY

Reservoir Data

R1 TITLE
R2 0 0 IWRIT IECON
R3 DEPTH PFORM TFORM
R4 TNET PERM POROS
R5 SOI 0.0 SWI
R6 API VISO BOI BWI
R7 AREA WELLSP ARIN FWA SWEEP BRNMX
R8 END (Enter if IECON=0)

Economic Data

E1 TITLE
E2 M ISTATE IDIST IOUT IFIT IDAT NCT NCI IDISC ISO IDEBT
E3 PCTDBT DBTINT NYRRPY NYPAID (Enter if IDEBT=1)
E4 CCOST GTRT WTRT CTACR DCE PLANT
E5 WOCOST WTCOST WDCOST COSTML COSTTI
E6 WCAP COSTRT UNCO
E7 WPP1 WPP2 WPP3 WPP4
E8 XDR XINF XROY XSEV XFIT XTCR DTIM XSTX
E9 XWPT WPHO EPHO BTIM BPOW
E10 OILB OILC DECL
E11 VOS(1), VOS(2), ... VOS(M) (Enter if ISO=1)
E12 ESCPO ESCFO ESCED ESCCT ESCCI ESCWO
E13 PAT(1), PAT(2), ... PAT(M)
E14 POL(1) POM(1) POH(1)
E15 FOCL(1) FOCM(1) FOCH(1)
E16 OPCL(1) OPCM(1) OPCH(1)
E17 EDPL(1) EDPM(1) EDPH(1)
E18 CTPL CTPM CTPH (Enter if NCI=1)
E19 CIPL CIPM CIPH (Enter if NCT=1)
E20 END

Appendix C
POLYMER FLOOD PREDICTIVE MODEL
INPUT DATA DESCRIPTION

DETAILS OF RESERVOIR AND ECONOMIC DATA ENTRY ARE GIVEN HERE. A CONDENSED SUMMARY OF THE DATA ENTRY IS GIVEN IN TABLE 2-1.

THREE TYPES OF DATA ARE INDICATED (NO BLANK DATA ALLOWED):

1. "REQUIRED" DATA - PROGRAM WILL NOT RUN UNLESS A VALUE GREATER THAN ZERO IS ENTERED. REQUIRED DATA ARE API GRAVITY (CARD R4), POROSITY(R7 OR R9), PERMEABILITY(R7 OR R9), NET PAY(R7 OR R9), INITIAL WATER SATURATION(R7 OR R9), DEPTH(R13), AND PATTERN AREA(R13). SEE TABLE 2-5 FOR ERROR CHECKS IF REQUIRED DATA NOT INPUT.
2. "DEFAULT" DATA - ENTER ZERO, UNLESS SPECIFIED OTHERWISE, TO DEFAULT TO THE VALUE INDICATED. VALUES GREATER THAN ZERO ARE USED AS SPECIFIED, UNLESS MINIMUM/MAXIMUM BOUNDS ARE INDICATED.
3. "NO DEFAULT" DATA - ANY VALUE ENTERED, INCLUDING ZERO, IS USED AS SPECIFIED.

2.1 RESERVOIR DATA

```
CARD R1 ***** READ TITLE
  READ(IR,) TITLE
    MAY BE UP TO 80 ALPHA-NUMERIC CHARACTERS

CARD R2 ***** READ RUN CONTROLS
  READ(IR,) IOUT, IOPT, IAROPT, IECON, ILIT
    IOUT   - CONTROLS PRINTING OF RESULTS OF RESERVOIR CALCULATIONS
             (NO DEFAULT, SEE TABLE 2-2 AND SECTION 4.1)
             = 0, MINIMUM OUTPUT, INCLUDES FORMATION AND FLUID
                  PROPERTIES, AND PATTERN INJ/PROD REPORTS
             =10, ALSO PRINTS OIL RECOVERY, FRACTIONAL FLOW DATA, AND
                  MOBILITIES BY LAYER
    IOPT   - WATER/POLYMER FLOOD CONTROL (NO DEFAULT)
             = 0, WATERFLOOD
             = 1, POLYMER FLOOD
             = 2, POLYMER FLOOD LESS WATERFLOOD = INCREMENTAL
    IAROPT - AREAL SWEEP CALCULATION CONTROL (NO DEFAULT)
             = 0, ONE STREAMTUBE USED IN EACH LAYER
             = 1, FOUR STREAMTUBES USED IN EACH LAYER
             = 2, EIGHT STREAMTUBES USED IN EACH LAYER
```

```
    IECON  - CONTROLS ECONOMIC ANALYSIS (NO DEFAULT)
             = 0, NO ECONOMIC CALCULATIONS, OMIT CARDS E1 TO E21
             = 1, ECONOMIC ANALYSIS, READ CARDS E1 TO E21
             = 2, ECONOMIC ANALYSIS AND PLOTS, READ CARDS E1 TO E21
    ILIT   - LITHOLOGY INDICATOR (NO DEFAULT)
             = 0,1 SANDSTONE
             = 2   CARBONATE

CARD R3 ***** READ FLUID DATA
  READ(IR,) BO,BW,VISW,VISO
    BO   - OIL FORMATION VOLUME FACTOR, RB/STB
           (DEFAULT: SEE SECTION 3.1)
    BW   - WATER FORMATION VOLUME FACTOR, RB/STB
           (DEFAULT: BW=1.0+1.2E-04*(TEMP-60.)+1.0E-06*(TEMP-60.)**2-
           3.33E-06*PFORM, CURVE FIT OF DATA OF KEENAN AND KEYES, 1936)
    VISW - WATER VISCOSITY, CP (DEFAULT: VISW=EXP(1.003-1.479E-02*TEMP+
           1.982E-05*TEMP**2, VAN WINGEN CORRELATION, API, 1950)
    VISO - OIL VISCOSITY, CP (DEFAULT: SEE SECTION 3.1)

CARD R4 ***** READ FLUID DATA
  READ(IR,) API,TEMP,GOR,SSG,PFORM
    API   - OIL GRAVITY, DEG. API (REQUIRED)
    TEMP  - FORMATION TEMPERATURE, DEG. F (DEFAULT:TEMP=60.+DEPTH*0.017)
    GOR   - SOLUTION GAS-OIL RATIO, SCF/STB (FOR GOR OF 0.0, ENTER 0.0;
            TO INVOKE DEFAULT, ENTER -1.0. SEE SECTION 3.1 FOR DEFAULT)
    SSG   - SPECIFIC GRAVITY OF GAS (W.R.T. AIR), FRACTION (DEFAULT=0.8)
    PFORM - FORMATION PRESSURE, PSIA (DEFAULT: PFORM=15.+DEPTH*0.433)

CARD R5 ***** READ DYKSTRA-PARSONS COEFFICIENT
  READ(IR,) VDP
    VDP - DYKSTRA-PARSONS COEFFICIENT FOR VERTICAL PERMEABILITY
          VARIATION (DEFAULT=0.72)

-------------------------------------------------------------------------
       IF THE DETAIL LAYER DATA (SWI,PHI,PERM AND PAY) FOR EACH LAYER
         ARE KNOWN, INPUT -1.0 FOR VDP ON CARD R5 AND SKIP TO CARD R8
-------------------------------------------------------------------------

CARD R6 ***** READ RESERVOIR LAYER DATA
  READ(IR,) LYROPT,NLDP
    LYROPT - DISCRETE LAYER CALCULATION OPTION (THIS OPTION CALCULATES
             LAYER PERMEABILITIES OF 5 TO 10 NDLP LAYERS BASED ON VDP
             READ ON CARD R5 AND PERM READ ON CARD R7. THE POROSITIES
             AND INITIAL WATER SATURATIONS OF ALL LAYERS ARE ASSUMED
             EQUAL WITH VALUES PHI AND SWIT, RESPECTIVELY, AS READ ON
             CARD R7. SEE SECTION 1.6)
             = 1, EQUAL THICKNESS ASSUMPTION (DEFAULT CALCULATION)
             = 2, EQUAL PERMEABILITY THICKNESS PRODUCT ASSUMPTION
    NLDP   - NUMBER OF DISCRETE LAYERS (MINIMUM NO. LAYERS=5,
             MAXIMUM=10)
```

```
CARD R7 ***** READ RESERVOIR DESCRIPTION DATA
  READ(IR,) PHI,PERM,PAY,SWIT
    PHI  - AVERAGE POROSITY, FRACTION (REQUIRED)
    PERM - AVERAGE PERMEABILITY, MD (REQUIRED)
    PAY  - TOTAL NET THICKNESS, FT (REQUIRED)
    SWIT - AVERAGE INITIAL WATER SATURATION (AT START OF FLOOD),
           FRACTION (REQUIRED)

-----------------------------------------------------------------------
  **** SKIP TO CARD R10 ****
-----------------------------------------------------------------------

CARD R8 ***** READ NUMBER OF LAYERS
  READ(IR,) NLAYER
    NLAYER - NUMBER OF LAYERS (MIN=1, MAX=10)

CARD R9 ***** READ LAYER PROPERTIES  (READ NLAYER CARDS)
  READ(IR,) I,PHIL(I),PERML(I),PAYL(I),SWIL(I),I=1,NLAYER
    I        - LAYER NUMBER
    PHIL(I)  - POROSITY OF LAYER I, FRACTION (REQUIRED)
    PERML(I) - PERMEABILITY OF LAYER I, MD (REQUIRED)
    PAYL(I)  - NET THICKNESS OF LAYER I, FT (REQUIRED). NOTE: USING
               THIS OPTION, PAYL(I) CAN BE DIFFERENT FOR EACH LAYER.
    SWIL(I)  - INITIAL WATER SATURATION OF LAYER I (AT START OF FLOOD),
               FRACTION (REQUIRED). NOTE: USING THIS OPTION, SWIL(I)
               CAN BE DIFFERENT FOR EACH LAYER.

CARD R10 ***** READ POLYMER DATA
  READ(IR,) CONCP,VISP,RF,DSPAF,RRF,VPMB,VIMAX
    CONCP - POLYMER CONCENTRATION, PPM (NO DEFAULT; FOR WATERFLOOD
            (IOPT=0 ON CARD R2), MODEL SETS CONCP=0.0).
            RECOMMENDED VALUE IN RANGE 600.0 - 1000.0 PPM.
    VISP  - POLYMER VISCOSITY, CP (DEFAULT; VISP=VISW*RF/RRF; VISP
            SUBSEQUENTLY MULTIPLIED BY RRF TO GIVE APPARENT VISCOSITY.
            FOR WATERFLOOD, MODEL SETS VISP=VISW)
    RF    - RESISTANCE FACTOR (DEFAULT: (IF RF .LE. 1.0) RF = 8.0; RF
            USED ONLY TO DEFAULT VISP ON THIS CARD AND XKPL ON CARD R11;
            SEE SECTION 1.8)
    DSPAF - POLYMER ADSORPTION, LB/AC FT (NO DEFAULT; FOR WATERFLOOD
            MODEL SETS DSPAF = 0.0). RECOMMENDED VALUE IS 150 LBS/AC FT.
    RRF   - RESIDUAL RESISTANCE FACTOR (DEFAULT: IF(RRF.LE.1.0) RRF=2.0;
            FOR WATERFLOOD, MODEL SETS RRF = 1.0; SEE SECTION 1.8)
    VPMB  - POLYMER SLUG SIZE, P.V. (NO DEFAULT; FOR WATERFLOOD, MODEL
            SETS VPMB=VIMAX)
    VIMAX - MAXIMUM PORE VOLUMES TO BE INJECTED, P.V. (DEFAULT = 3.0)

CARD R11 ***** READ POLYMER VISCOSITY POWER-LAW FACTORS
  READ(IR,) XKPL,XNPL
    XKPL - POWER LAW COEFFICIENT, CP*SEC**(N-1), DEFAULT: XKPL=VISW*RF
    XNPL - POWER LAW EXPONENT (N), DIMENSIONLESS (DEFAULT=0.6). FOR
           WATERFLOOD, MODEL SETS XNPL=1.0. XNPL BOUNDED BY 0.0001 AND
           0.999. SEE SECTION 1.8 FOR POWER-LAW MODEL.
```

```
CARD R12 ***** READ RELATIVE PERMEABILITY DATA
                (NOTE: SEE TABLE 2-3 FOR RELATIVE PERMEABILITY
                RELATIONSHIPS)
  READ(IR,) SWC,SORW,XKROE,XKRWE,XNO,XNW
    SWC   - CONNATE WATER SATURATION,FRACTION
            (DEFAULT: IF(SWC.LE.0.3) SWC=0.3)
    SORW  - RESIDUAL OIL SATURATION TO WATER, FRACTION (DEFAULTS:
            IF(SORW.LE.0.0 .AND. ILIT.LE.1) SORW=0.25 (SANDSTONE);
            IF(SORW.LE.0.0 .AND. ILIT.GT.1) SORW=0.38 (CARBONATE))
    XKROE - OIL RELATIVE PERMEABILITY AT SWC, FRACTION (DEFAULTS:
            IF(XKROE .LE.0.0 .AND. ILIT.LE.1) XKROE=0.8 (SANDSTONE);
            IF(XKROE .LE.0.0 .AND. ILIT.GT.1) XKROE=0.4 (CARBONATE))
    XKRWE - WATER RELATIVE PERMEABILITY AT SORW, FRACTION (DEFAULTS:
            IF(XKRWE .LE.0.0 .AND. ILIT.LE.1) XKRWE=0.2 (SANDSTONE);
            IF(XKRWE .LE.0.0 .AND. ILIT.GT.1) XKRWE=0.3 (CARBONATE))
    XNO   - OIL CURVE EXPONENT, FRACTION (DEFAULT=2.0)
    XNW   - WATER CURVE EXPONENT, FRACTION (DEFAULT=2.0)

CARD R13 ***** READ RESERVOIR DESCRIPTION DATA
  READ(IR,) DEPTH,APAT,RW,CP,QRES
    DEPTH - RESERVIOR DEPTH, FT (REQUIRED)
    APAT  - PATTERN AREA, ACRES (REQUIRED)
    RW    - WELLBORE RADIUS, FT (DEFAULT=0.5)
    CP    - INJECTIVITY COEFFICIENT, PSI/FT  NOTE: CP*DEPTH=MAXIMUM
            PRESSURE DROP BETWEEN INJECTOR AND PRODUCER. CP RANGES FROM
            ABOUT 0.7 IF THE INJECTORS ARE INJECTING AT THEIR FRACTURE
            LIMIT AND THE PRODUCERS ARE COMPLETELY PUMPED OFF, TO ABOUT
            0.27 IF THE PRODUCERS HAVE A WATER HEAD. SEE SECTION 1.5.
            (DEFAULTS: IF(DEPTH.LE.3000..AND.CP.LE.0.0) CP=(200.+0.433*
            DEPTH)/DEPTH; IF(DEPTH.GT.3000..AND.CP.LE.0.0) CP=((200.+
            0.433*3000.)+0.003*(DEPTH-3000.0))/DEPTH)
    QRES  - INJECTION RATE OVERRIDE, RB/D (IF QRES =0.0, VARIABLE INJ.
            RATE CALCULATED USING CP READ ON THIS CARD. IF QRES .GT. 0.,
            QRES USED AS CONSTANT INJ. RATE OVER LIFE OF FLOOD.)

CARD R14 ***** READ END CARD (READ ONLY IF IECON = 0 ON CARD R2)
  READ (IR,) END
    END - "END" IN COLUMNS 1-4
```

2.2 ECONOMIC DATA

THE FOLLOWING CARDS ARE TO BE READ IF IECON =1 ON CARD R2

CARD E1 ***** READ ECONOMIC TITLE
  READ(IR,) TITLE
    MAY BE UP TO 80 ALPHA-NUMERIC CHARACTERS

CARD E2 ***** READ CASE CONTROLS
  READ(IR,) M,ISTATE,IDIST,IOUT,IFIT,IDAT,NCT,NCI,IDISC,
            ISO,IPLIF,IDEBT
    M   - NUMBER OF YEARS IN THE PROJECT (FOR ALL PATTERNS)
             M MUST BE .LE. 50
    ISTATE - STATE CODE. USED TO DEFAULT WELL CAPITAL COSTS
             (DRILLING, COMPLETION, CONVERSION, UPGRADING)
             BY REGION OF U.S. SEE SECTION 3.2 FOR EXPLANATION OF
             OF DEFAULTS BY REGION. TO INVOKE DEFAULTS FOR WELL
             CAPITAL COSTS, ENTER THE APPROPRIATE NUMBER 1-52 FROM THE
             TABLE BELOW, AND WPP'S AS REQUIRED ON CARD E4.

CODE	ALPHA	STATE	CODE	ALPHA	STATE
1	AL	ALABAMA	27	NV	NEVADA
2	AZ	ARIZONA	28	NH	NEW HAMPSHIRE
3	AR	ARKANSAS	29	NJ	NEW JERSEY
4	CA	CALIFORNIA	30	NM	NEW MEXICO
5	CO	COLORADO	31	NY	NEW YORK
6	CT	CONNECTICUT	32	NC	N.CAROLINA
7	DE	DELAWARE	33	ND	N.DAKOTA
8	DC	WASH D.C.	34	OH	OHIO
9	FL	FLORIDA	35	OK	OKLAHOMA
10	GA	GEORGIA	36	OR	OREGON
11	ID	IDAHO	37	PA	PENNSYLVANIA
12	IL	ILLINOIS	38	RI	RHODE ISLAND
13	IN	INDIANA	39	SC	S.CAROLINA
14	IA	IOWA	40	SD	S.DAKOTA
15	KS	KANSAS	41	TN	TENNESSEE
16	KY	KENTUCKY	42	TX	TEXAS
17	LA	LOUISIANA	43	UT	UTAH
18	ME	MAINE	44	VT	VERMONT
19	MD	MARYLAND	45	VA	VIRGINIA
20	MA	MASS	46	WA	WASHINGTON
21	MI	MICHIGAN	47	WV	WEST VIRGINIA
22	MN	MINNESOTA	48	WI	WISCONSIN
23	MS	MISSISSIPPI	49	WY	WYOMING
24	MO	MISSOURI	50	AK	ALASKA
25	MT	MONTANA	51	HI	HAWAII
26	NE	NEBRASKA	52	PO	OFFSHORE

TO DISABLE DEFAULTS FOR WELL COSTS, ENTER WPP1=WPP2=WPP3=
WPP4=0.0 ON CARD E4. THEN WELL COSTS MAY, IF DESIRED,
BE ENTERED AS PART OF CAPITAL COSTS ON CARDS E19-E20. IF
WPP'S=0.0 ON CARD E4 AND ISTATE = 1-52 ON THIS CARD, THEN
MODEL PENALIZES OIL PRICE BASED ON API GRAVITY AND
LOCATION. SEE SECTION 3.2 FOR EXPLANATION OF PENALITIES.
IF PROJECT IS OUTSIDE U.S. OR IT IS DESIRED TO DISABLE OIL
PRICE PENALTY, ENTER WPP'S = 0.0 ON CARD E4 AND ISTATE = 53
ON THIS CARD. NOTE: IF ISTATE = 53 SELECTED, USER MUST
ENTER WPP'S = 0.0 ON CARD E4.

IDIST - DISTRICT CODE (WITHIN A STATE). USED TO DEFAULT WELL COSTS.
SEE SECTION 3.2 FOR DEFAULTS. IF OUTSIDE U.S. OR IF
ISTATE= 53, ENTER IDIST=0. FOR TEXAS RAILROAD COMMISSION
(RRC) DISTRICTS, ENTER (RRC NO. * 10) + Y, WHERE

Y = 1 FOR A
= 2 FOR B
= 3 FOR C

EG., FOR DISTRICT 10B ENTER 102, ETC.

IOUT - CONTROLS PRINTING OF ECONOMIC CALCULATIONS (NO DEFAULT,
SEE TABLE 2-2 AND SECTION 4.1)
= 0, MINIMUM OUTPUT, PRINTS ECONOMIC SUMMARY
= 1, ALSO PRINTS ANNUAL CASH FLOW, PROJECT CAPITAL
SCHEDULE, AND UNDISCOUNTED RESULTS
= 2, ALSO PRINTS ESCALATED VALUES OF PRICES AND COSTS

IFIT - FEDERAL INCOME TAX CREDIT OPTION (NO DEFAULT)
= 0, ALLOWS A TAX CREDIT TO OFFSET LOSSES
= 1, NO TAX CREDIT ALLOWED

IDAT - CONTROL FOR READING PRICE AND COST DATA
= 0, DEFAULT PRICES AND COSTS USED, SKIP CARDS E13-E18;
SEE E13-E18 FOR DEFAULT VALUES
= 1, READ CARDS E13-E18 FOR PRICE AND COST DATA

NCT - CONTROL FOR READING TANGIBILE CAPITAL INVESTMENT PER
PATTERN IN ANY GIVEN YEAR. INVESTMENTS WILL BE TIMED
ACCORDING TO PATTERN SCHEDULE ON CARD E12.
= 0, DO NOT READ TANGIBLE CAPITAL INVESTMENT ON CARD E19
= 1, READ TANGIBLE CAPITAL INVESTMENT ON CARD E19

NCI - CONTROL FOR READING INTANGIBLE CAPITAL INVESTMENT PER
PATTERN IN ANY GIVEN YEAR. INVESTMENTS WILL BE TIMED
ACCORDING TO PATTERN SCHEDULE ON CARD E12.
= 0, DO NOT READ INTANGIBLE CAPITAL INVESTMENT ON CARD E20
= 1, READ INTANGIBLE CAPITAL INVESTMENT ON CARD E20

IDISC - CONTROL FOR DISCOUNTING METHOD (NO DEFAULT)
= 0, YEAR END DISCOUNTING FACTORS USED
= 1, MID-YEAR DISCOUNTING FACTORS USED

```
    ISO    - CONTROL FOR READING SECONDARY OIL VOLUMES (NO DEFAULT)
             = 0, DO NOT READ SECONDARY OIL VOLUMES
             = 1, READ SECONDARY OIL VOLUMES ON CARD E11
    IPLIF  - CONTROL ON ECONOMIC LIFE (NO DEFAULT)
             = 0, ECONOMIC LIFE BASED ON AFTER TAX CASH FLOW
             = 1, ECONOMIC LIFE BASED ON NET OPERATING INCOME
    IDEBT  - CONTROL ON DEBT CALCULATIONS (NO DEFAULT)
             = 0, NO CAPITAL BORROWING DEBT CALCULATIONS
             = 1, INCLUDE CAPITAL BORROWING BASED ON DATA INPUT
                  ON CARD E3

CARD E3 ***** READ DEBT CONTROLS (READ IF IDEBT = 1 ON CARD E2)
  READ(IR,) PCTDBT,DBTINT,NYRRPY,NYPAID
    PCTDBT - PERCENT OF CAPITAL (TANGIBLE AND INTANGIBLE) COSTS
             TO BE BORROWED, PERCENT (DEFAULT=20.)
    DBTINT - DEBT INTEREST RATE, PERCENT (DEFAULT=15.)
    NYRRPY - NUMBER OF YEARS BEFORE BEGINNING DEBT REPAYMENT
             (DEFAULT=1.)
    NYPAID - NUMBER OF YEARS BEFORE COMPLETING DEBT REPAYMENT
             (DEFAULT=5.)

CARD E4 ***** READ DRILLING DATA
  READ(IR,) WPP1,WPP2,WPP3,WPP4
            (ENTER ALL ZEROS IF WELL CAPITAL COSTS INCLUDED ON CARDS
            E19-E20. SEE SECTION 3.2 FOR WELL CAPITAL COSTS DEFAULT
            EQUATIONS USING WPP'S.)
    WPP1 - NUMBER OF INJECTORS DRILLED PER PATTERN (NO DEFAULT)
    WPP2 - NUMBER OF PRODUCERS DRILLED PER PATTERN (NO DEFAULT)
    WPP3 - NUMBER OF PRIMARY PRODUCERS CONVERTED TO SECONDARY PRODUCERS
           PER PATTERN (NO DEFAULT)
    WPP4 - NUMBER OF EXISTING PRODUCERS CONVERTED TO INJECTORS
           PER PATTERN (NO DEFAULT)

CARD E5 ***** READ OPERATING AND PLANT CAPITAL DATA
        CAPITAL FOR PLANTS (CCHM, CWAT) ON THIS CARD WILL BE TAKEN IN
        THE FIRST YEAR OF THE PROJECT AND WILL BE ADDED TO CAPITAL FOR
        WELLS (IF ANY), WHETHER LATTER CAPITAL IS DEFAULTED ON CARD E7
        OR READ ON CARDS E19-E20.
  READ(IR,) CCHM,CSCAP,CWAT,CWCAP,WOCOST,WTCOST
    CCHM   - CAPITAL FOR POLYMER HANDLING PLANT, M$
             (DEFAULT: CCHM=0.1*1000.0*RMAX**0.6, WHERE RMAX IS
             CALCULATED MAX. INJ. RATE OVER LIFE OF PROJECT IN MBBL/DAY.
             MODEL ZEROS CCHM FOR WATERFLOOD.)
    CSCAP  - CAPACITY OF POLYMER PLANT, MMB/YR (DEFAULT: CSCAP=365.*
             RMAX/1000.0)
    CWAT   - CAPITAL FOR WATER INJECTION PLANT, M$ (NO DEFAULT; ESTIMATE
             IS 40.0 * RMAX M$.
    CWCAP  - CAPACITY OF WATER INJECTION PLANT, MMB/YR
             (DEFAULT: CWCAP=365.*RMAX/1000.0)
```

```
    WOCOST - ANNUAL WELL WORKOVER COST PER PATTERN, M$
             (DEFAULT: 0.25*CNVT. ASSUMES ONE WORKOVER PER PATTERN
             EVERY FOUR YEARS. CNVT IS THE COST TO CONVERT AN EXISTING
             PRODUCER TO AN INJECTION WELL. SEE SECTION 3.2 FOR DEFAULT
             FOR CNVT. FOR INCREMENTAL CASE, IOPT=2 ON CARD R2, WORKOVER
             COSTS ARE SET TO ZERO UNTIL WATERFLOOD LIFE EXCEEDED.)
    WTCOST - PRODUCED WATER TREATING COSTS, $/BBL (DEFAULT=0.03)

CARD E6 ***** READ OPERATING DATA
  READ(IR,) WCAP, UNCO, COSTRT
    WCAP   - MONTHS OF WORKING CAPITAL, MONTHS (NO DEFAULT)
    UNCO   - OIL RATE UNCERTAINTY, FRACTION (DEFAULT= 0.001)
    COSTRT - PROJECT STARTUP COSTS, M$ (NO DEFAULT; THE NEGATIVE OF
             COSTRT IS USED TO INITIALIZE CASH FLOW)

CARD E7 ***** READ TAXES AND MONETARY DATA
  READ(IR,) XDR,XINF,XROY,XSEV,XFIT,XTCR,DTIM,XSTX
    XDR  - MONETARY DISCOUNT RATE (DEFAULT= 0.1)
    XINF - INFLATION RATE (NO DEFAULT)
    XROY - ROYALTY RATE (NO DEFAULT)
    XSEV - SEVERANCE TAX RATE (NO DEFAULT)
    XFIT - FEDERAL INCOME TAX RATE (NO DEFAULT)
    XTCR - INVESTMENT TAX CREDIT (NO DEFAULT)
    DTIM - INVESTMENT DEPRECIATION TIME, YR (NO DEFAULT)
           IF DTIM = 0.0, MODEL USES ACCELERATED CAPITAL RECOVERY
           SYSTEM (5 YEAR DEPRECIATION) ACCORDING TO 1981 TAX ACT.
           IF DTIM .GT. 0.0, USES STRAIGHT LINE DEPRECIATION FROM
           YEAR OF INVESTMENT OVER DTIM YEARS.
    XSTX - STATE INCOME TAX RATE (NO DEFAULT)

CARD E8 ***** READ WINDFALL EXCISE (PROFIT) TAX DATA
  READ(IR,) XWPT,WPHO,EPHO,BTIM,BPOW
    XWPT - WINDFALL EXCISE TAX RATE. IF 0.0 THEN IGNORES TAX.
           SEE SECTION 3.2 FOR EXPLANATION OF WINDFALL EXCISE TAX.
    WPHO - WINDFALL TAX BEGINNING PHASE OUT DATE (DEFAULT= 1991.)
    EPHO - WINDFALL TAX ENDING PHASE OUT DATE (DEFAULT= 1993.)
    BTIM - BASE TIME FOR PROJECT START (DEFAULT= 1985.)
    BPOW - BASE OIL PRICE AT START OF PROJECT FOR WPT CALCULATIONS
           ONLY, $/BBL (DEFAULT= 23.07*(1.+XINF)**(BTIM-1983.)
           NOTE: OIL PRICE FOR SALES AND REVENUE PURPOSES IS ENTERED OR
           DEFAULTED ON CARD E13)

CARD E9 ***** READ ESCALATION DATA FOR PRICES AND COSTS
  READ(IR,) ESCPO,ESCPG,ESCPI,ESCFO,ESCTR,ESCWT,ESCWI,ESCWO
    ESCPO - ESCALATION RATE OF OIL PRICE (NO DEFAULT)
    ESCPG - ESCALATION RATE OF GAS PRICE (NO DEFAULT)
    ESCPI - ESCALATION RATE OF POLYMER PRICE (NO DEFAULT)
    ESCFO - ESCALATION RATE OF OPERATING COSTS (NO DEFAULT)
    ESCTR - ESCALATION RATE OF POLYMER HANDLING COST (NO DEFAULT)
    ESCWT - ESCALATION RATE OF TANGIBLE CAPITAL (NO DEFAULT)
    ESCWI - ESCALATION RATE OF INTANGIBLE CAPITAL (NO DEFAULT)
    ESCWO - ESCALATION RATE OF WELL WORKOVER COST (NO DEFAULT)
```

```
CARD E10 ***** READ SECONDARY OIL PRODUCTION DATA
  READ(IR,) OILB,OILC,DECL
    OILB - 1979 PROJECT BASE OIL RATE, MBBL/YR (DEFAULT = 0.)
    OILC - CURRENT NON-TERTIARY PROJECT OIL RATE, MBBL/YR
           (DEFAULT = OILB * (1.-DECL)**(BTIM-1979.))
    DECL - ANNUAL OIL PRODUCTION DECLINE RATE, PERCENT (DEFAULT = 15.)

CARD E11 ***** READ SECONDARY OIL PRODUCTION CURVE
         (READ IF ISO = 1 ON CARD E2)
  READ(IR,) (VOS(I),I=1,M)
    VOS(I) - VOLUME OF SECONDARY OIL PER PATTERN EACH YEAR, MBBL/YR
             (NOTE: IF ISO=0, MODEL DEFAULTS VOS(I)=OILC*
             (1.-DECL)**(FLOAT(I)-0.5); TO OBTAIN VOS(I)=0.0,
             SET OILB=0.0 ON CARD E10)

CARD E12 ***** READ PROJECT PATTERN SCHEDULE
  READ(IR,) (PATI(I),I=1,M)
    PATI(I) - NUMBER OF PATTERNS INITIATED EACH YEAR OF THE PROJECT
              (NO DEFAULT)

-----------------------------------------------------------------------
IF IDAT=0 ON CARD E2, MODEL USES DEFAULT PRICES AND COSTS; SKIP TO
CARD E19
-----------------------------------------------------------------------

      IN ALL OF THE FOLLOWING ARRAYS, THE LAST LETTER (H, M, OR L)
 MEANS HIGH, MOST LIKELY, OR LOW VALUE OF THE PARAMETER IN A
 GIVEN YEAR.  THE HIGH AND LOW VALUES SHOULD BE CHOSEN TO
 REPRESENT A CONFIDENCE LEVEL OF 80 PERCENT.  LOW PRICE HAS A 90%
 CHANCE OF BEING OBTAINED, AND THE HIGH PRICE HAS ONLY A 10%
 CHANCE OF BEING REACHED. SEE SECTION 1.9 FOR DISCUSSION OF RISK.

      PRICES AND COSTS, WHETHER ENTERED OR DEFAULTED, ARE SCALED BY
 PROGRAM (SUBROUTINE ECFTR) DUE TO VARIATION IN OIL PRICE FROM
 $30.00/BBL. THE PRICE FACTOR IS FACT=(POM(1)-30.00)/30., WHERE
 POM(1) IS ENTERED OR DEFAULTED ON CARD E13.  THEN:

          DRILLING AND COMPLETION FACTOR = 1.0 +(0.4 * FACT)
          EQUIPMENT FACTOR = 1.0 +(0.3 * FACT)
          OPERATING COSTS FACTOR = 1.0 +(0.2 * FACT)
          POLYMER PRICE FACTOR = 1.0 + (0.3913 * FACT)
          OIL PRICE FACTOR = 1.0 + FACT

CARD E13 ***** READ OIL PRICE DATA
  READ(IR,) POL(1),POM(1),POH(1)
    POL(1) - LOW OIL PRICE, $/BBL (DEFAULT= POM(1) * 0.8)
    POM(1) - MOST LIKELY OIL PRICE, $/BBL (DEFAULT= 30.00. THIS READ OR
             DEFAULTED OIL PRICE MAY SUBSEQUENTLY BE REDUCED BASED ON
             API GRAVITY AND LOCATION. SEE SECTION 3.2 FOR DISCUSSION
             OF OIL PRICE PENALITIES.)
    POH(1) - HIGH OIL PRICE, $/BBL (DEFAULT = POM(1) *1.2)
```

```
CARD E14 ***** READ GAS PRICE DATA
  READ(IR,) PGL(1),PGM(1),PGH(1)
    PGL(1) - LOW GAS PRICE, $/MSCF (DEFAULT=PGM(1)*0.8)
    PGM(1) - MOST LIKELY GAS PRICE, $/MSCF (DEFAULT=POM(1)/6.0)
    PGH(1) - HIGH GAS PRICE, $/MSCF (DEFAULT=PGM(1)*1.2)

CARD E15 ***** READ POLYMER PRICE DATA
  READ(IR,) PPL(1),PPM(1),PPH(1)
    PPL(1) - LOW POLYMER PRICE, $/LB (DEFAULT=1.28)
    PPM(1) - MOST LIKELY POLYMER PRICE, $/LB (DEFAULT=1.60)
    PPH(1) - HIGH POLYMER PRICE, $/LB (DEFAULT=1.92)

CARD E16 ***** READ FIXED ANNUAL OPERATING COST DATA
         (INCLUDES MAINTENANCE, OTHER COSTS THAT DO NOT DEPEND ON OIL
         RATE. FOR INCREMENTAL CASE, IOPT=2 ON CARD R2, FIXED OPERATING
         COSTS ARE SET TO ZERO UNTIL WATERFLOOD LIFE EXCEEDED.)
  READ(IR,) FOCL(1),FOCM(1),FOCH(1)
    FOCL(1) - LOW FIXED OPERATING COST PER PATTERN, $/YR
              (DEFAULT: FOCL(1)=(CDAO+CIWO)*0.8, WHERE CDAO (OPER COSTS
              FOR SEC RECOVERY) AND CIWO (ADDITIONAL OPER COSTS FOR
              OFFSHORE WAT INJ PLANT) ARE DEFAULTED IN SECTION 3.2)
    FOCM(1) - MOST LIKELY FIXED OPERATING COST PER PATTERN, $/YR
              (DEFAULT: FOCM(1)=(CDAO+CIWO))
    FOCH(1) - HIGH FIXED OPERATING COST PER PATTERN, $/YR
              (DEFAULT: FOCH(1)=(CDAO+CIWO)*1.2)

CARD E17 ***** READ VARIABLE ANNUAL OPERATING COST DATA
         (INCLUDES LIFTING AND OTHER COSTS THAT DEPEND ON OIL PRODUCTION
          DIRECTLY, BUT NOT ROYALTY OR SEVERANCE)
  READ(IR,) OPCL(1),OPCM(1),OPCH(1)
    OPCL(1) - LOW VARIABLE OPERATING COST, $/BBL OIL PRODUCED
              (DEFAULT= 0.04)
    OPCM(1) - MOST LIKELY VARIABLE OPERATING COST, $/BBL OIL PRODUCED
              (DEFAULT= 0.05)
    OPCH(1) - HIGH VARIABLE OPERATING COST, $/BBL OIL PRODUCED
              (DEFAULT= 0.06)

CARD E18 ***** READ POLYMER HANDLING/TREATING COST DATA
         (INCLUDES FILTERING,MIXING,OXYGEN SCAVENGERS, BACTERICIDES,
         ETC.)
  READ(IR,) TRPL(1),TRPM(1),TRPH(1)
    TRPL(1) - LOW POLYMER HANDLING COST, $/BBL POLY SOLN (DEFAULT=0.08)
    TRPM(1) - MOST LIKELY POLYMER HANDLING COST, $/BBL POLY SOLN
              (DEFAULT=0.10)
    TRPH(1) - HIGH POLYMER HANDLING COST, $/BBL POLY SOLN (DEFAULT=0.12)
```

```
CARD E19 ***** READ TANGIBLE CAPITAL INVESTMENT (READ IF NCT=1
         ON CARD E2)
         (FLOW LINES, WELLS, ROADS, AND PRODUCTION FACILITIES.)
         IF WELLS ENTERED ON CARD E4, DO NOT ENTER WELL CAPITAL
         COSTS ON THIS CARD.
  READ(IR,) ICT,CTPL,CTPM,CTPH
    ICT  - ENTER 1.0
    CTPL - LOW TANGIBLE CAPITAL COST PER PATTERN, $ (NO DEFAULT)
    CTPM - MOST LIKELY TANGIBLE CAPITAL COST PER PATTERN, $ (NO DEFAULT)
    CTPH - HIGH TANGIBLE CAPITAL COST PER PATTERN, $ (NO DEFAULT)

CARD E20 ***** READ INTANGIBLE CAPITAL INVESTMENT (READ IF NCI=1
         ON CARD E2)
         (CAPITAL EXPENSED IN A GIVEN YEAR.)  IF WELLS ENTERED ON
         CARD E4, DO NOT ENTER WELL CAPITAL COSTS ON THIS CARD.
  READ(IR,) ICI,CIPL,CIPM,CIPH
    ICI  - ENTER 1.0
    CIPL - LOW INTANGIBLE CAPITAL COST PER PATTERN, $ (NO DEFAULT)
    CIPM - MOST LIKELY INTANGIBLE CAPITAL COST PER PATTERN, $
           (NO DEFAULT)
    CIPH - HIGH INTANGIBLE CAPITAL COST PER PATTERN, $ (NO DEFAULT)

CARD E21 ***** READ END CARD
  READ (IR,) END
    END - "END" IN COLUMNS 1-4

********** RETURN TO CARD R1 FOR NEW CASE ***********
```

TABLE 2-1
PFPM DATA ENTRY

Reservoir Data

```
R1  TITLE
R2  IOUT, IOPT, IAROPT, IECON, ILIT
R3  BO, BW, VISW, VISO
R4  API, TEMP, GOR, SGG, PFORM
R5  VDP
*** SKIP TO R8 IF VDP = -1.0 ***
R6  LYROPT, NLDP
R7  PHI, PERM, PAY, SWIT
*** SKIP TO R10 ***
R8  NLAYER
R9  I, PHIL(I), PERML(I), PAY(I), SWIL(I), I=1, NLAYER
R10 CONCP, VISP, RF, DSPAF, RRF, VPMB, VIMAX
R11 XKPL, XNPL
R12 SWC, SORW, XKROE, XKRWE, XNO, XNW
R13 DEPTH, APAT, RW, CP, QRES
R14 END (ENTER IF IECON=0)
```

Economic Data

```
E1  TITLE
E2  M, ISTATE, IDIST, IOUT, IFIT, IDAT, NCT, NCI, IDISC, ISO, IPLIF,
  IDEBT
E3  PCTDBT, DBTINT, NYRRPY, NYPAID (ENTER IF IDEBT=1)
E4  WPP1, WPP2, WPP3, WPP4
E5  CCHM, CSCAP, CWAT, CWCAP, WOCOST, WTCOST
E6  WCAP, UNCO, COSTRT
E7  XDR, XINF, XROY, XSEV, XFIT, XTCR, DTIM, XSTX
E8  XWPT, WPHO, EPHO, BTIM, BPOW
E9  ESCPO, ESCPG, ESCPI, ESCFO, ESCTR, ESCWT, ESCWI, ESCWO
E10 OILB, OILC, DECL
E11 VOS(I), I=1, M (ENTER IF ISO=1)
E12 PAT(I), I=1, M
*** SKIP TO E19 IF IDAT=0 ***
E13 POL(1), POM(1), POH(1)
E14 PGL(1), PGM(1), PGH(1)
E15 PPL(1), PPM(1), PPH(1)
E16 FOCL(1), FOCM(1), FOCH(1)
E17 OPCL(1), OPCM(1), OPCH(1)
E18 TRPL(1), TRPM(1), TRPH(1)
E19 ICT, CTPL, CTPM, CTPH (ENTER IF NCT=0)
E20 ICI, CIPL, CIPM, CIPH (ENTER IF NCI=0)
E21 END
```

Appendix D
CHEMICAL FLOOD PREDICTIVE MODEL
INPUT DATA DESCRIPTION

DETAILS OF RESERVOIR AND ECONOMIC DATA ENTRY ARE GIVEN HERE. A CONDENSED SUMMARY OF THE DATA ENTRY IS GIVEN IN TABLE 2-1.

THREE TYPES OF DATA ARE INDICATED (NO BLANK DATA ALLOWED):

1. "REQUIRED" DATA - PROGRAM WILL NOT RUN UNLESS A VALUE GREATER THAN ZERO IS ENTERED. REQUIRED DATA ARE API GRAVITY (CARD R5), POROSITY (R6), PERMEABILITY (R6), NET PAY (R6), DEPTH (R9),AND PATTERN AREA (R9). SEE TABLE 2-5 FOR ERROR CHECKS IF REQUIRED DATA NOT INPUT.
2. "DEFAULT" DATA - ENTER ZERO, UNLESS SPECIFIED OTHERWISE, TO DEFAULT TO THE VALUE INDICATED. VALUES GREATER THAN ZERO ARE USED AS SPECIFIED, UNLESS MINIMUM/MAXIMUM BOUNDS ARE INDICATED.
3. "NO DEFAULT" DATA - ANY VALUE ENTERED, INCLUDING ZERO, IS USED AS SPECIFIED.

2.1 RESERVOIR DATA

CARD R1 ***** READ TITLE
READ(IR,) TITLE
MAY BE UP TO 80 ALPHA-NUMERIC CHARACTERS

CARD R2 ***** READ RUN CONTROLS
READ(IR,) IECON,ICAUST,ILIT,NPC

IECON - CONTROLS ECONOMIC ANALYSIS (NO DEFAULT)
= 0, NO ECONOMIC CALCULATIONS, OMIT CARDS E1 TO E22
= 1, ECONOMIC ANALYSIS, READ CARDS E1 TO E22
= 2, ECONOMIC ANALYSIS AND PLOTS, READ CARDS E1 TO E22

ICAUST - CONTROLS FLOOD TYPE (NO DEFAULT)
(NOTE: IF ICAUST .GT. 0, NPC BELOW MUST BE .EQ. 0)
= 0, MICELLAR-POLYMER (SURFACTANT-POLYMER)
= 1, CAUSTIC FLOOD (IMPLEMENTED CASE, SEE SECTION 1.5 AND TABLE 1-1)
= 2, CAUSTIC-POLYMER FLOOD (SEE SECTION 1.5 AND TABLE 1-1)
= 3, CAUSTIC-POLYMER FLOOD (ADVANCED CASE, SEE SECTION 1.5 AND TABLE 1-1)

ILIT - LITHOLOGY INDICATOR (NO DEFAULT)
= 0, 1 SANDSTONE
= 2 CARBONATE

NPC - SWITCH FOR NPC MODIFICATIONS TO ORIGINAL CFPM (SEE SECTION 1.3)
= 0 ORIG MODEL (RECOMMENDED FOR HIGH-WATER-CONTENT AND LOW VISCOSITY SOLUBLE-OIL SLUGS)
= 1 USES NPC MODIFICATIONS (RECOMMENDED FOR VERY VISCOUS SOLUBLE-OIL SLUGS)

```
CARD R3 ***** READ RESERVOIR DATA
  READ(IR,) TEMP,TMAX,SALIN,SMAX,PFORM
    TEMP   - RESERVOIR TEMPERATURE, DEG. F
             (DEFAULT:TEMP=60.0+DEPTH*GGRAD, WHERE GGRAD=0.017 DEG.F/FT)
    TMAX   - MAXIMUM ALLOWABLE RESERVOIR TEMPERATURE, DEG. F
             (DEFAULT= 200. MODEL WILL NOT RUN IF TEMP .GT. TMAX)
    SALIN  - FORMATION WATER SALINITY, PPM TDS (DEFAULT = 50000.)
    SMAX   - MAXIMUM ALLOWABLE FORMATION WATER SALINITY, PPM TDS
             (DEFAULT = 100000. MODEL WILL NOT RUN IF SALIN .GT. SMAX)
    PFORM  - RESERVOIR PRESSURE, PSIA (DEFAULT: PFORM=15.+DEPTH*0.433)

CARD R4 ***** READ RESERVOIR DATA
  READ(IR,) OOIP,COIL,FBW,FGC,RS
    OOIP    - ORIGINAL OIL-IN-PLACE IN DEVELOPED AREA, MMSTB
              (NO DEFAULT, BUT IF OOIP.LE.0.0, THEN COIL BELOW MUST BE
              .GT. 0.0)
    COIL    - CUMULATIVE OIL PRODUCED AT END OF WATERFLOOD, MMSTB
              (NO DEFAULT, BUT IF COIL .LE. 0.0, THEN SORW (CARD R8)
              MUST BE .GT. 0.0)
    FBW     - FRACTION OOIP UNDERLAIN BY BOTTOM WATER (NO DEFAULT,
              BOUNDED BY 0.0 AND 1.0)
    FGC     - FRACTION OOIP COVERED BY GAS CAP (NO DEFAULT, BOUNDED BY
              0.0 AND 1.0)
    RS      - SOLUTION GAS-OIL RATIO, SCF/STB (FOR RS OF 0.0, ENTER 0.0;
              TO INVOKE DEFAULT ENTER -1.0. SEE SECTION 3.1 FOR DEFAULT)

CARD R5 ***** READ FLUID PROPERTIES
  READ(IR,) BOI,BOF,BWF,VISO,VISW,API,SGG
    BOI     - INITIAL (DISCOVERY) OIL FORMATION VOLUME FACTOR, RB/STB
              (DEFAULT: SEE SECTION 3.1)
    BOF     - FINAL OIL FORMATION VOLUME FACTOR (AT END OF WATERFLOOD),
              RB/STB (DEFAULT = 1.0)
    BWF     - FINAL WATER FORMATION VOLUME FACTOR (AT END OF WATERFLOOD)
              (DEFAULT = 1.0 + 1.2E-4*(TEMP-60.)+1.0E-6*(TEMP-60.)**2-
              3.33E-6*PFORM)
    VISO    - OIL VISCOSITY, CP (DEFAULT: SEE SECTION 3.1)
    VISW    - WATER VISCOSITY, CP (DEFAULT:VISW=EXP(1.003-1.479E-2*TEMP+
              1.982E-5*TEMP**2),VAN WINGEN CORRELATION, API, 1950)
    API     - OIL GRAVITY, DEG. API (REQUIRED)
    SGG     - GAS SPECIFIC GRAVITY W.R.T. AIR, FRACTION (DEFAULT= 0.8)

CARD R6 ***** READ RESERVOIR PROPERTIES DATA
  READ(IR,) PHI, PERM, PAY, VDP, DSIN, WCLAY, KVKH
    PHI     - POROSITY, FRACTION (REQUIRED)
    PERM    - PERMEABILITY, MD (REQUIRED)
    PAY     - NET PAY THICKNESS, FT (REQUIRED)
    VDP     - DYKSTRA-PARSONS COEFFICIENT (DEFAULT= 0.72)
```

```
    DSIN   - USER SPECIFIED SURFACTANT RETENTION IN UNITS OF PORE
             VOLUME. IF DSIN = 0.0, MODEL COMPUTES RETENTION, DS,
             BASED ON WCLAY BELOW. IF DSIN .GT. 0.0, DSIN OVERRIDES DS
             CALCULATION. (DEFAULT=0.0)
    WCLAY  - WEIGHT FRACTION CLAY (DEFAULT=0.1); USED TO COMPUTE
             SURFACTANT RETENTION IN PORE VOLUMES, DS, IF DSIN = 0.0
             ABOVE, FROM THE EQUATION (FOR SANDSTONE) DS = ((1.0-PHI)/
             PHI)*(RHOR/RHOS)*(1.0/CS)*((3.3*WCLAY)/1000.0). NOTE: IF
             NPC = 1, MODEL SETS DS = 0.1154)
    XKVKH  - KV/KH RATIO (NO DEFAULT)

CARD R7 ***** READ CHEMICAL PROPERTIES
  READ(IR,) RHOR, RHOS, CS, VPSDS, EDIN
    RHOR   - ROCK GRAIN DENSITY, G/ML (DEFAULT= 2.68)
    RHOS   - SURFACTANT SLUG DENSITY, G/ML (DEFAULT= 1.0)
    CS     - INJECTED SURFACTANT CONCENTRATION IN SLUG, VOLUME FRACTION
             (DEFAULT= 0.05)
    VPSDS  - DIMENSIONLESS SURFACTANT SLUG SIZE. VPSDS IS EQUAL TO THE
             ACTUAL PV SURFACTANT SLUG INJECTED (VPS) DIVIDED BY DS OR
             DSIN (DEFAULT = 1.3)
    EDIN   - USER SPECIFIED DISPLACEMENT EFFICIENCY, USUALLY FROM LARGE
             SLUG COREFLOOD (DEFAULT: CALCULATED FROM CAPILLARY NO. IN
             SUBROUTINE CAPNO)

CARD R8 ***** READ RELATIVE PERMEABILITY DATA
  READ(IR,) SWC, SORW, KORO, KORW, XNO, XNW
          (NOTE: SEE TABLE 2-3 FOR RELATIVE PERMEABILITY RELATIONSHIPS)
    SWC    - CONNATE WATER SATURATION, FRACTION (DEFAULT = 0.3)
    SORW   - RESIDUAL OIL SATURATION AT END OF WATERFLOOD, FRACTION
             (DEFAULTS: IF (SORW.LE.0.0.AND.ILIT.LE.1) SORW=0.25
             (SANDSTONE);
             IF (SORW.LE.0.0 AND.ILIT.GT.1) SORW=0.38 (CARBONATE))
    KORO   - OIL RELATIVE PERMEABILITY AT SWC (DEFAULTS:
             IF (KORO.LE.0.0.AND.ILIT.LT.1) KORO=0.8 (SANDSTONE);
             IF (KORO.LE.0.0.AND.ILIT.GT.1) KORO=0.4 (CARBONATE)
    KORW   - WATER RELATIVE PERMEABILITY AT SORW (DEFAULTS:
             IF (KORW.LE.0.0.AND.ILIT.LE.1) KORW=0.2 (SANDSTONE);
             IF (KORW.LE.0.0.AND.ILIT.GT.1) KORW=0.3 (CARBONATE)
    XNO    - OIL RELATIVE PERMEABILITY CURVE EXPONENT (DEFAULT = 2.0)
    XNW    - WATER RELATIVE PERMEABILITY CURVE EXPONENT (DEFAULT = 2.0)

CARD R9 ***** READ RESERVOIR DESCRIPTION
  READ(IR,) DEPTH, APAT, QSS, CP, VPMB
    DEPTH  - RESERVOIR DEPTH, FEET (REQUIRED)
    APAT   - PATTERN AREA, ACRES (REQUIRED)
    QSS    - STEADY STATE PATTERN RATE, RB/D (DEFAULT: QSS = 0.003541*
             CP*PERM*PAY*DEPTH/(VISO*TRL*(5.58+0.5*ALOG(A))), WHERE
             A = APAT/2.0 IS THE WELL SPACING, AND TRL IS AN EMPIRICAL
             FACTOR WITH TRL = 1.25 IF NPC = 0 ON CARD R2, TRL = 2.5
             IF NPC = 1)
```

```
    CP      - INJECTIVITY COEFFICIENT, PSI/FT (DEFAULT = 0.3)
              NOTE: CP *DEPTH = MAXIMUM PRESSURE DROP BETWEEN INJECTOR
              AND PRODUCER. CP RANGES FROM ABOUT 0.7 IF THE INJECTORS
              ARE AT FRACTURE LIMIT AND THE PRODUCERS ARE COMPLETELY
              PUMPED OFF, TO ABOUT 0.27 IF THE PRODUCERS HAVE A WATER
              HEAD.
    VPMB    - PORE VOLUME POLYMER (MOBILITY BUFFER) INJECTED, FRACTION
              (DEFAULTS: IF (ICAUST .EQ. 0) VPMB = 0.65;
                         IF (ICAUST .EQ. 1) VPMB = 0.001;
                         IF (ICAUST .GE. 2) VPMB = 0.4)

CARD R10 ***** READ END CARD (READ ONLY IF IECON = 0 ON CARD R2)
  READ (IR,) END
    END - "END" IN COLUMNS 1-4
```

2.2 ECONOMIC DATA

```
THE FOLLOWING CARDS ARE TO BE READ IF IECON =1 ON CARD R2

CARD E1 ***** READ TITLE
  READ(IR,) TITLE
    THIS IS UP TO 80 ALPHA-NUMERIC CHARACTERS

CARD E2 ***** READ CASE CONTROLS
  READ(IR,) M,ISTATE,IDIST,IOUT,IFIT,IDAT,NCT,NCI,IDISC,
            ISO,IPLIF,IDEBT
    M       - NUMBER OF YEARS IN THE PROJECT (FOR ALL PATTERNS)
              M MUST BE .LE. 50
    ISTATE  - STATE CODE. USED TO DEFAULT WELL CAPITAL COSTS
              (DRILLING, COMPLETION, CONVERSION, UPGRADING)
              BY REGION OF U.S. SEE SECTION 3.2 FOR EXPLANATION OF
              OF DEFAULTS BY REGION. TO INVOKE DEFAULTS FOR WELL
              CAPITAL COSTS, ENTER THE APPROPRIATE NUMBER 1-52 FROM THE
              TABLE BELOW, AND WPP'S AS REQUIRED ON CARD E4.
```

CODE	ALPHA	STATE	CODE	ALPHA	STATE
1	AL	ALABAMA	27	NV	NEVADA
2	AZ	ARIZONA	28	NH	NEW HAMPSHIRE
3	AR	ARKANSAS	29	NJ	NEW JERSEY
4	CA	CALIFORNIA	30	NM	NEW MEXICO
5	CO	COLORADO	31	NY	NEW YORK
6	CT	CONNECTICUT	32	NC	N.CAROLINA
7	DE	DELAWARE	33	ND	N.DAKOTA
8	DC	WASH D.C.	34	OH	OHIO
9	FL	FLORIDA	35	OK	OKLAHOMA
10	GA	GEORGIA	36	OR	OREGON
11	ID	IDAHO	37	PA	PENNSYLVANIA
12	IL	ILLINOIS	38	RI	RHODE ISLAND
13	IN	INDIANA	39	SC	S.CAROLINA
14	IA	IOWA	40	SD	S.DAKOTA
15	KS	KANSAS	41	TN	TENNESSEE
16	KY	KENTUCKY	42	TX	TEXAS
17	LA	LOUISIANA	43	UT	UTAH
18	ME	MAINE	44	VT	VERMONT
19	MD	MARYLAND	45	VA	VIRGINIA
20	MA	MASS	46	WA	WASHINGTON
21	MI	MICHIGAN	47	WV	WEST VIRGINIA
22	MN	MINNESOTA	48	WI	WISCONSIN
23	MS	MISSISSIPPI	49	WY	WYOMING
24	MO	MISSOURI	50	AK	ALASKA
25	MT	MONTANA	51	HI	HAWAII
26	NE	NEBRASKA	52	PO	OFFSHORE

TO DISABLE DEFAULTS FOR WELL COSTS, ENTER WPP1=WPP2=WPP3= WPP4=0.0 ON CARD E4. THEN WELL COSTS MAY, IF DESIRED, BE ENTERED AS PART OF CAPITAL COSTS ON CARDS E20-E21. IF WPP'S=0.0 ON CARD E4 AND ISTATE = 1-52 ON THIS CARD, THEN MODEL PENALIZES OIL PRICE BASED ON API GRAVITY AND LOCATION. SEE SECTION 3.2 FOR EXPLANATION OF PENALITIES. IF PROJECT IS OUTSIDE U.S. OR IT IS DESIRED TO DISABLE OIL PRICE PENALTY, ENTER WPP'S = 0.0 ON CARD E4 AND ISTATE = 53 ON THIS CARD. NOTE: IF ISTATE = 53 SELECTED, USER MUST ENTER WPP'S = 0.0 ON CARD E4.

IDIST - DISTRICT CODE (WITHIN A STATE). USED TO DEFAULT WELL COSTS. SEE SECTION 3.2 FOR DEFAULTS. IF OUTSIDE U.S. OR IF ISTATE= 53, ENTER IDIST=0. FOR TEXAS RAILROAD COMMISSION (RRC) DISTRICTS, ENTER (RRC NO. * 10) + Y, WHERE

Y = 1 FOR A
= 2 FOR B
= 3 FOR C

EG., FOR DISTRICT 10B ENTER 102, ETC.

```
    IOUT   - CONTROLS PRINTING OF ECONOMIC CALCULATIONS (NO DEFAULT,
             SEE TABLE 2-2 AND SECTION 4.1)
             = 0, MINIMUM OUTPUT, PRINTS ECONOMIC SUMMARY
             = 1, ALSO PRINTS ANNUAL CASH FLOW, PROJECT CAPITAL
                  SCHEDULE, AND UNDISCOUNTED RESULTS
             = 2, ALSO PRINTS ESCALATED VALUES OF PRICES AND COSTS
    IFIT   - FEDERAL INCOME TAX CREDIT OPTION (NO DEFAULT)
             = 0, ALLOWS A TAX CREDIT TO OFFSET LOSSES
             = 1, NO TAX CREDIT ALLOWED
    IDAT   - CONTROL FOR READING PRICE AND COST DATA
             = 0, DEFAULT PRICES AND COSTS USED, SKIP CARDS E13-E19;
               SEE E13-E19 FOR DEFAULT VALUES
             = 1, READ CARDS E13-E19 FOR PRICE AND COST DATA
    NCT    - CONTROL FOR READING TANGIBILE CAPITAL INVESTMENT PER
             PATTERN IN ANY GIVEN YEAR. INVESTMENTS WILL BE TIMED
             ACCORDING TO PATTERN SCHEDULE ON CARD E12.
             = 0, DO NOT READ TANGIBLE CAPITAL INVESTMENT ON CARD E20
             = 1, READ TANGIBLE CAPITAL INVESTMENT ON CARD E20
    NCI    - CONTROL FOR READING INTANGIBLE CAPITAL INVESTMENT PER
             PATTERN IN ANY GIVEN YEAR. INVESTMENTS WILL BE TIMED
             ACCORDING TO PATTERN SCHEDULE ON CARD E12.
             = 0, DO NOT READ INTANGIBLE CAPITAL INVESTMENT ON CARD E21
             = 1, READ INTANGIBLE CAPITAL INVESTMENT ON CARD E21
    IDISC  - CONTROL FOR DISCOUNTING METHOD (NO DEFAULT)
             = 0, YEAR END DISCOUNTING FACTORS USED
             = 1, MID-YEAR DISCOUNTING FACTORS USED
    ISO    - CONTROL FOR READING SECONDARY OIL VOLUMES (NO DEFAULT)
             = 0, DO NOT READ SECONDARY OIL VOLUMES
             = 1, READ SECONDARY OIL VOLUMES ON CARD E11
    IPLIF  - CONTROL ON ECONOMIC LIFE (NO DEFAULT)
             = 0, ECONOMIC LIFE BASED ON AFTER TAX CASH FLOW
             = 1, ECONOMIC LIFE BASED ON NET OPERATING INCOME
    IDEBT  - CONTROL ON DEBT CALCULATIONS (NO DEFAULT)
             = 0, NO CAPITAL BORROWING DEBT CALCULATIONS
             = 1, INCLUDE CAPITAL BORROWING BASED ON DATA INPUT
                  ON CARD E3

CARD E3 ***** READ DEBT CONTROLS (READ IF IDEBT = 1 ON CARD E2)
  READ(IR,) PCTDBT,DBTINT,NYRRPY,NYPAID
    PCTDBT - PERCENT OF CAPITAL (TANGIBLE AND INTANGIBLE) COSTS
             TO BE BORROWED, PERCENT. (DEFAULT=20.)
    DBTINT - DEBT INTEREST RATE, PERCENT (DEFAULT=15.)
    NYRRPY - NUMBER OF YEARS BEFORE BEGINNING DEBT REPAYMENT
             (DEFAULT=1)
    NYPAID - NUMBER OF YEARS BEFORE COMPLETING DEBT REPAYMENT
             (DEFAULT=5)
```

```
CARD E4 ***** READ DRILLING DATA
  READ(IR,) WPP1,WPP2,WPP3,WPP4
      (ENTER ALL ZEROS IF WELL CAPITAL COSTS INCLUDED ON CARDS
      E20-21. SEE SECTION 3.2 FOR WELL CAPITAL COSTS DEFAULT
      EQUATIONS USING WPP'S.)
    WPP1 - NUMBER OF INJECTORS DRILLED PER PATTERN (NO DEFAULT)
    WPP2 - NUMBER OF PROCUCERS DRILLED PER PATTERN (NO DEFAULT)
    WPP3 - NUMBER OF PRIMARY PRODUCERS CONVERTED TO SECONDARY
           PRODUCERS PER PATTERN (NO DEFAULT)
    WPP4 - NUMBER OF EXISTING PRODUCERS CONVERTED TO INJECTORS PER
           PATTERN (NO DEFAULT)

CARD E5 ***** READ OPERATING DATA
  READ(IR,) CCHM,CSCAP,CWAT,CWCAP,WOCOST,WTCOST
    CCHM   - CAPITAL FOR CHEMICAL HANDLING, M$ (DEFAULT: CCHM=AFAC*
             1000.0*RMAX**0.6, WHERE AFAC=0.25 IF ICAUST=1, AFAC= 0.5
             IF ICAUST=0 OR >1, AND RMAX IS THE CALCULATED MAX.
             SURFACTANT (OR CAUSTIC) SLUG INJ. RATE OVER LIFE OF
             FLOOD IN MBBL/DAY.)
    CSCAP  - CAPACITY OF CHEMICAL PLANT, MMB/YR
             (DEFAULT: CSCAP = 365. * RMAX/1000.0)
    CWAT   - CAPITAL FOR WATER INJECTION PLANT, M$ (NO DEFAULT;
             ESTIMITE IS 40. * RMAX1, WHERE RMAX1 IS CALCULATED MAX.
             WATER INJ. RATE OVER LIFE OF FLOOD IN MBBL/DAY)
    CWCAP  - CAPACITY OF WATER INJECTION PLANT, MMB/YR
             (DEFAULT: CWCAP = 365. * RMAX1/1000.0).
    WOCOST - ANNUAL WELL WORKOVER COST PER PATTERN, M$
             (DEFAULT: 0.25*CNVT. ASSUMES ONE WORKOVER PER PATTERN
             EVERY FOUR YEARS. CNVT IS THE COST TO CONVERT AN EXISTING
             PRODUCER TO AN INJECTION WELL. SEE SECTION 3.2 FOR DEFAULT
             FOR CNVT.
    WTCOST - PRODUCED WATER TREATING AND INJECTION COST, $/BBL
             (DEFAULT = 0.03)

CARD E6 ***** READ OPERATING DATA
  READ(IR,) WCAP,UNCO,COSTRT
    WCAP   - MONTHS OF WORKING CAPITAL, MONTHS (NO DEFAULT)
    UNCO   - OIL VOLUME UNCERTAINTY, FRACTION (DEFAULT = 0.001)
    COSTRT - PROJECT STARTUP COSTS, M$ (NO DEFAULT; THE NEGATIVE OF
             COSTRT IS USED TO INITIALIZE CASH FLOW)

CARD E7 ***** READ TAXES AND ESCALATION FACTORS
  READ(IR,) XDR,XINF,XROY,XSEV,XFIT,XTCR,DTIM,XSTX
    XDR  - MONETARY DISCOUNT RATE (DEFAULT = 0.10)
    XINF - INFLATION RATE (NO DEFAULT)
    XROY - ROYALTY RATE (NO DEFAULT)
    XSEV - SEVERANCE TAX RATE (NO DEFAULT)
    XFIT - FEDERAL INCOME TAX RATE (NO DEFAULT)
    XTCR - INVESTMENT TAX CREDIT (NO DEFAULT)
```

```
    DTIM - INVESTMENT DEPRECIATION TIME, YR (NO DEFAULT)
           IF DTIM = 0.0, MODEL USES ACCELERATED CAPITAL RECOVERY
           SYSTEM (5 YEAR DEPRECIATION) ACCORDING TO 1981 TAX ACT
           (SEE TABLE 2-4). IF DTIM .GT. 0.0, USES STRAIGHT LINE
           DEPRECIATION FROM YEAR OF INVESTMENT OVER DTIM YEARS.
    XSTX - STATE INCOME TAX RATE (NO DEFAULT)

CARD E8 ***** READ WINDFALL EXCISE TAX DATA
  READ(IR,) XWPT,WPHO,EPHO,BTIM,BPOW
    XWPT - WINDFALL EXCISE TAX RATE. IF 0.0 THEN IGNORES TAX. SEE
           SECTION 3.2 FOR EXPLANATION OF WINDFALL EXCISE TAX.
    WPHO - WINDFALL TAX BEGINNING PHASE OUT DATE (DEFAULT 1991)
    EPHO - WINDFALL TAX ENDING PHASE OUT DATE (DEFAULT 1995)
    BTIM - BASE TIME FOR PROJECT START (DEFAULT 1985)
    BPOW - BASE OIL PRICE AT START OF PROJECT FOR WPT CALCULATIONS
           ONLY, $/BBL (DEFAULT = 23.07 * (1.*XINF)**(BTIM-1983.))
           (NOTE: OIL PRICE FOR SALES AND REVENUE PURPOSES IS ENTERED
           OR DEFAULTED ON CARD E13)

CARD E9 ***** READ ESCALATION DATA
  READ(IR,) ESCPO,ESCPG,ESCPI,ESCFO,ESCTR,ESCCT,ESCCI,ESCWO
    ESCPO - ESCALATION RATE OF OIL PRICE (NO DEFAULT)
    ESCPG - ESCALATION RATE OF GAS PRICE (NO DEFAULT)
    ESCPI - ESCALATION RATE OF CHEMICAL PRICE (NO DEFAULT)
    ESCFO - ESCALATION RATE OF OPERATING COSTS (NO DEFAULT)
    ESCTR - ESCALATION RATE OF CHEMICAL HANDLING COST (NO DEFAULT)
    ESCCT - ESCALATION RATE OF TANGIBLE CAPITAL (NO DEFAULT)
    ESCCI - ESCALATION RATE OF INTANGIBLE CAPITAL (NO DEFAULT)
    ESCWO - ESCALATION RATE OF WELL WORKOVER COST (NO DEFAULT)

CARD E10 ***** SECONDARY OIL PRODUCTION DATA
  READ(IR,) OILB,OILC,DECL
    OILB - 1979 PROJECT BASE OIL RATE, MBBL/YR (DEFAULT = 0.)
    OILC - CURRENT NON-TERTIARY PROJECT OIL RATE, MBBL/YR
           (DEFAULT = OILB * (1.-DECL)**(BTIM-1979))
    DECL - ANNUAL OIL RATE DECLINE RATE, FRACTION (DEFAULT = 15.)

CARD E11 ***** READ SECONDARY OIL PRODUCTION CURVE
         (READ IF ISO = 1 ON CARD E2)
  READ(IR,) (VOS(I),I=1,M)
    VOS(I) - VOLUME OF SECONDARY OIL PER PATTERN EACH YEAR, MBBL/YR
             (NOTE: IF ISO=0, MODEL DEFAULTS VOS(I)=OILC*
             (1.-DECL)**(FLOAT(I)-0.5); TO OBTAIN VOS(I)=0.0,
             SET OILB=0.0 ON CARD E10)

CARD E12 ***** READ PROJECT PATTERN SCHEDULE
  READ(IR,) (PATI(I),I=1,M)
    PATI(I) - NUMBER OF PATTERNS INITIATED EACH YEAR OF THE PROJECT
              (NO DEFAULT)
```

IF IDAT=0 ON CARD E2, MODEL USES DEFAULT PRICES AND COSTS; SKIP TO CARD E20

IN ALL OF THE FOLLOWING ARRAYS, THE LAST LETTER (H, M, OR L) MEANS HIGH, MOST LIKELY, OR LOW VALUE OF THE PARAMETER IN A GIVEN YEAR. THE HIGH AND LOW VALUES SHOULD BE CHOSEN TO REPRESENT A CONFIDENCE LEVEL OF 80 PERCENT. LOW PRICE HAS A 90% CHANCE OF BEING OBTAINED, AND THE HIGH PRICE HAS ONLY A 10% CHANCE OF BEING REACHED. SEE SECTION 1.6 FOR DISCUSSION OF RISK.

PRICES AND COSTS, WHETHER ENTERED OR DEFAULTED, ARE SCALED BY PROGRAM (SUBROUTINE ECFTR) DUE TO VARIATION IN OIL PRICE FROM $30.00/BBL. THE PRICE FACTOR IS FACT=(POM(1)-30.00)/30., WHERE POM(1) IS ENTERED OR DEFAULTED ON CARD E13. THEN:

```
DRILLING AND COMPLETION FACTOR = 1.0 +(0.4 * FACT)
EQUIPMENT FACTOR = 1.0 +(0.3 * FACT)
OPERATING COSTS FACTOR = 1.0 +(0.2 * FACT)
SURFACTANT PRICE FACTOR = 1.0 + (0.6209 * FACT)
CAUSTIC PRICE FACTOR = 1.0 + (0.3913 * FACT)
POLYMER PRICE FACTOR = 1.0 + (0.3913 * FACT)
OIL PRICE FACTOR = 1.0 + FACT
```

CARD E13 ***** READ OIL PRICE DATA

READ(IR,) POL(1),POM(1),POH(1)

- POL(1) - LOW OIL PRICE, $/BBL (DEFAULT= POM(1) * 0.8)
- POM(1) - MOST LIKELY OIL PRICE, $/BBL (DEFAULT= 30.00. THIS READ OR DEFAULTED OIL PRICE MAY SUBSEQUENTLY BE REDUCED BASED ON API GRAVITY AND LOCATION. SEE SECTION 3.2 FOR DISCUSSION OF OIL PRICE PENALITIES.)
- POH(1) - HIGH OIL PRICE, $/BBL (DEFAULT = POM(1) *1.2)

CARD E14 ***** READ GAS PRICE DATA

READ(IR,) PGL(1),PGM(1),PGH(1)

- PGL(1) - LOW GAS PRICE, $/MSCF (DEFAULT=PGM(1)*0.8)
- PGM(1) - MOST LIKELY GAS PRICE, $/MSCF (DEFAULT=POM(1)/6.0)
- PGH(1) - HIGH GAS PRICE, $/MSCF (DEFAULT=PGM(1)*1.2)

CARD E15 ***** READ SURFACTANT (CAUSIC) SLUG PRICE DATA

READ(IR,) PIL(1),PIM(1),PIH(1)

- PIL(1) - LOW SLUG PRICE, $/BBL (DEFAULT = PIM(1) * 0.8)
- PIM(1) - MOST LIKELY SLUG PRICE, $/BBL (SURFACTANT DEFAULT = 7.00; CAUSTIC DEFAULTS: IF (ICAUST .EQ. 1) PIM(1) = 0.60; IF (ICAUST .GT. 1) PIM(1) = 1.90)
- PIH(1) - HIGH SLUG PRICE, $/BBL (DEFAULT = PIM(1) * 1.2)

```
CARD E16 ***** READ POLYMER PRICE DATA
  READ(IR,) PPL(1),PPM(1),PPH(1)
    PPL(1) - LOW POLYMER PRICE, $/LB (DEFAULT = 1.28)
    PPM(1) - MOST LIKELY POLYMER PRICE, $/LB (DEFAULT = 1.60)
    PPH(1) - HIGH POLYMER PRICE, $/LB (DEFAULT = 1.92)

CARD E17 ***** READ FIXED ANNUAL OPERATING COST DATA
   (INCLUDES MAINTENANCE, OTHER COSTS THAT DO NOT DEPEND ON OIL RATE)
  READ(IR,) FOCL(1),FOCM(1),FOCH(1)
    FOCL(1) - LOW FIXED  OPERATING COST PER PATTERN, $/YR
              (DEFAULT: FOCL(1) = FOCM(1) * 0.8)
    FOCM(1) - MOST LIKELY FIXED OPERATING COST PER PATTERN, $/YR
              (DEFAULT: FOCM(1) = 0.5 * (CDAO+CIWO) * (WPP1+WPP2),
              WHERE CDAO (OPER. COSTS FOR SEC. RECOVERY) AND CIWO
              (ADDITIONAL OPER. COSTS FOR OFFSHORE WATER INJECTION
              PLANT) ARE DEFAULTED IN SECTION 3.2)
    FOCH(1) - HIGH FIXED OPERATING COST PER PATTERN, $/YR
              (DEFAULT: FOCH(1) = FOCM(1) * 1.2)

CARD E18 ***** READ VARIABLE ANNUAL OPERATING COST DATA
   (INCLUDES LIFTING AND OTHER COSTS THAT DEPEND ON OIL PRODUCTION
   DIRECTLY, BUT NOT ROYALTY OR SEVERANCE)
  READ(IR,) OPCL(1),OPCM(1),OPCH(1)
    OPCL(1) - LOW VARIABLE OPERATING COSTS, $/BBL OIL PRODUCED
              (DEFAULT = 0.40)
    OPCM(1) - MOST LIKELY VARIABLE OPERATING COSTS, $/BBL OIL PRODUCED
              (DEFAULT = 0.50)
    OPCH(1) - HIGH VARIABLE OPERATING COSTS, $/BBL OIL PRODUCED
              (DEFAULT = 0.60)

CARD E19 ***** READ CHEMICAL HANDLING/TREATING COST DATA
         (INCLUDES FILTERING, MIXING, OXYGEN SCAVENGERS, BACTERICIDES,
         ETC.)
  READ(IR,) TRPL(1),TRPM(1),TRPH(1)
    TRPL(1) - LOW CHEMICAL HANDLING COST, $/BBL SLUG (DEFAULT = 0.08)
    TRPM(1) - MOST LIKELY CHEMICAL HANDLING COST, $/BBL SLUG
              (DEFAULT = 0.10)
    TRPH(1) - HIGH CHEMICAL HANDLING COST, $/BBL SLUG (DEFAULT = 0.12)

CARD E20 ***** READ TANGIBLE CAPITAL INVESTMENT (READ IF NCT=1
         ON CARD E2)
         (FLOW LINES, WELLS, ROADS, AND PRODUCTION FACILITIES.)
         IF WELLS ENTERED ON CARD E4, DO NOT ENTER WELL CAPITAL
         COSTS ON THIS CARD.
  READ(IR,) ICT,CTPL,CTPM,CTPH
    ICT  - ENTER 1.0
    CTPL - LOW TANGIBLE CAPITAL COST PER PATTERN, $ (NO DEFAULT)
    CTPM - MOST LIKELY TANGIBLE CAPITAL COST PER PATTERN, $ (NO DEFAULT)
    CTPH - HIGH TANGIBLE CAPITAL COST PER PATTERN, $ (NO DEFAULT)
```

```
CARD E21 ***** READ INTANGIBLE CAPITAL INVESTMENT (READ IF NCI=1
         ON CARD E2)
         (CAPITAL EXPENSED IN A GIVEN YEAR.)  IF WELLS ENTERED ON
         CARD E4, DO NOT ENTER WELL CAPITAL COSTS ON THIS CARD.
  READ(IR,) ICI,CIPL,CIPM,CIPH
    ICI  - ENTER 1.0
    CIPL - LOW INTANGIBLE CAPITAL COST PER PATTERN, $ (NO DEFAULT)
    CIPM - MOST LIKELY INTANGIBLE CAPITAL COST PER PATTERN, $
           (NO DEFAULT)
    CIPH - HIGH INTANGIBLE CAPITAL COST PER PATTERN, $ (NO DEFAULT)

CARD E22 ***** READ END CARD
  READ (IR,) END
    END - "END" IN COLUMNS 1-4

********** RETURN TO CARD R1 FOR NEW CASE ***********
```

TABLE 2-1
CFPM DATA ENTRY

Reservoir Data

```
R1    TITLE
R2    IECON, ICAUST, ILIT, NPC
R3    TEMP, TMAX, SALIN, SMAX, PFORM
R4    OOIP, COIL, FBW, FGC, RS
R5    BOI, BOF, BWF, VISO, VISW, API, SGG
R6    PHI, PERM, PAY, VDP, DSIN, WCLAY, XKVKH
R7    RHOR, RHOS, CS, VPSDS, EDIN
R8    SWC, SORW, KORO, KORW, XNO, XNW
R9    DEPTH, APAT, QSS, CP, VPMB
R10   END (ENTER IF IECON=0)
```

Economic Data

```
E1    TITLE
E2    M, ISTATE, IDIST, IOUT, IFIT, IDAT, NCT, NCI, IDISC, ISO, IPLIF,
      IDEBT
E3    PCTDBT, DBTINT, NYRRPY, NYPAID (ENTER IF IDEBT=1)
E4    WPP1, WPP2, WPP3, WPP4
E5    CCHM, CSCAP, CWAT, CWCAP, WOCOST, WTCOST
E6    WCAP, UNCO, COSTRT
E7    XDR, XINF, XROY, XSEV, XFIT, XTCR, DTIM, XSTX
E8    XWPT, WPHO, EPHO, BTIM, BPOW
E9    ESCPO, ESCPG, ESCPI, ESCFO, ESCTR, ESCCT, ESCCI, ESCWO
E10   OILB, OILC, DECL
E11   VOS(I), I=1, M (ENTER IF ISO=1)
E12   PAT(I), I=1, M
***   SKIP TO E19 IF IDAT=0 ***
E13   POL(1), POM(1), POH(1)
E14   PGL(1), PGM(1), PGH(1)
E15   PIL(1), PIM(1), PIH(1)
E16   PPL(1), PPM(1), PPH(1)
E17   FOCL(1), FOCM(1), FOCH(1)
E18   OPCL(1), OPCM(1), OPCH(1)
E19   TRPL(1), TRPM(1), TRPH(1)
E20   ICT, CTPL, CTPM, CTPH (ENTER IF NCT=0)
E21   ICI, CIPL, CIPM, CIPH (ENTER IF NCI=0)
E22   END
```

Appendix E
CO_2 MISCIBLE FLOOD PREDICTIVE MODEL INPUT DATA DESCRIPTION

DETAILS OF RESERVOIR AND ECONOMIC DATA ENTRY ARE GIVEN HERE. A CONDENSED SUMMARY OF THE DATA ENTRY IS GIVEN IN TABLE 2-1.

THREE TYPES OF DATA ARE INDICATED (NO BLANK DATA ALLOWED):

1. "REQUIRED" DATA - PROGRAM WILL NOT RUN UNLESS A VALUE GREATER THAN ZERO IS ENTERED. REQUIRED DATA ARE API GRAVITY (CARD R4), POROSITY(R3), PERMEABILITY(R3), NET PAY(R3), DEPTH(R3), AND PATTERN AREA(R3). SEE TABLE 2-5 FOR ERROR CHECKS IF REQUIRED DATA NOT INPUT.
2. "DEFAULT" DATA - ENTER ZERO, UNLESS SPECIFIED OTHERWISE, TO DEFAULT TO THE VALUE INDICATED. VALUES GREATER THAN ZERO ARE USED AS SPECIFIED, UNLESS MINIMUM/MAXIMUM BOUNDS ARE INDICATED.
3. "NO DEFAULT" DATA - ANY VALUE ENTERED, INCLUDING ZERO, IS USED AS SPECIFIED.

2.1 RESERVOIR DATA

CARD R1 ***** READ TITLE
  READ(IR,) TITLE
    MAY BE UP TO 80 ALPHA-NUMERIC CHARACTERS

CARD R2 ***** READ RUN CONTROLS
  READ(IR,) IRES, IOUT, ISOL, IECON
    IRES - TYPE OF RECOVERY CALCULATIONS (NO DEFAULT, SEE SECTION 1.1 FOR DISCUSSION OF IRES)
      = 1, 1-D CALCULATIONS (KOVAL)
      = 2, 2-D CALCULATIONS (KOVAL + AREAL SWEEP)
      = 3, 3-D CALCULATIONS (2-D + GRAVITY, RECOMMENDED FOR SCREENING)
    IOUT - CONTROLS PRINTING OF RESULTS OF RESERVOIR CALCULATIONS (NO DEFAULT, SEE TABLE 2-2 AND SECTION 4.1)
      = 0, PRINTS 3-D(OR 2-D) CONDENSED PATTERN SUMMARY FOR TOTAL LAYERS
      = 1, ALSO PRINTS CO2 FLUID PROPERTIES
      = 3, ALSO PRINTS 1-D SUMMARY AND 3-D(OR 2-D) PATTERN PRODUCTION AND INJECTION SCHEDULE FOR TOTAL LAYERS
      = 4, ALSO PRINTS 3-D(OR 2-D) PATTERN PRODUCTION SCHEDULES BY LAYER
      =10, ALSO PRINTS FRACTIONAL FLOW RESULTS (PATHS) AND AREAL SWEEP CALCS., BY LAYER (LENGTHY OUTPUT)
    ISOL - INDICATOR FOR SOLUBILITY OF CO2 IN WATER (NO DEFAULT)
      = 0, CO2 SOLUBILITY IN WATER NOT ACCOUNTED FOR
      = 1, CO2 SOLUBILITY IN WATER CALCULATED FROM TABLES IN SUBROUTINE PROPC (DODDS ET AL, 1956)

```
    IECON  - CONTROLS ECONOMIC ANALYSIS (NO DEFAULT)
             = 0, NO ECONOMIC CALCULATIONS, OMIT CARDS E1 TO E22
             = 1, ECONOMIC ANALYSIS, READ CARDS E1 TO E22
             = 2, ECONOMIC ANALYSIS AND PLOTS, READ CARDS E1 TO E22

CARD R3 *****  READ RESERVOIR DATA
  READ(IR,) PRES, TRES, POROS, THICK, AREA, PERM, DEPTH
    PRES   - RESERVOIR PRESSURE, PSIA (DEFAULT: PRES=15.0+DEPTH*PGRAD,
             WHERE PGRAD=0.433 PSI/FT)
    TRES   - RESERVOIR TEMPERATURE, DEG. F (DEFAULT: TRES=60.0=DEPTH*
             GGRAD, WHERE GGRAD=0.011 DEG.F/FT)
    POROS  - RESERVOIR POROSITY, FRACTION (REQUIRED)
    THICK  - NET PAY THICKNESS, FEET (REQUIRED)
    AREA   - PATTERN AREA, ACRE (REQUIRED)
    PERM   - RESERVOIR ABSOLUTE PERMEABILITY, MD (REQUIRED)
    DEPTH  - RESERVOIR DEPTH, FEET (REQUIRED)

CARD R4 *****  READ FLUID DATA
  READ(IR,) XKVH, SALN, BO, RS, BW, BCO2, API, SGG
    XKVH   - RATIO OF VERTICAL TO HORIZONTAL PERMEABILITY (NO DEFAULT;
             SUGGESTED VALUE = 0.1)
    SALN   - WATER SALINITY, PPM (DEFAULT = 50,000). USED TO MODIFY
             SOLUBILITY OF CO2 IN WATER (STEWART AND MUNJAL, 1970)
    BO     - OIL FORMATION VOLUME FACTOR, RB/STB(DEFAULT:SEE SECTION 3.1)
    RS     - SOLUTION GAS-OIL RATIO, SCF/STB (DEFAULT:SEE SECTION 3.1)
    BW     - WATER FORMATION VOLUME FACTOR, RB/STB (DEFAULT:BW=1.0+1.2E-4
             *(TRES-60.0)+1.0E-6*(TRES-60.0)**2-3.33E-6*PRES)
    BCO2   - CO2 FORMATION VOLUME FACTOR, RB/MSCF (DEFAULT:BCO2=5.03495
             *ZC*(TRES+460.0)/PRES), WHERE ZC IS THE CO2 COMPRESSIBILITY
             FACTOR CALCULATED INTERNALLY FROM TABLES IN SUBROUTINE PROPC
             (MICHELS ET AL, 1957))
    API    - API GRAVITY OF OIL, DEG. API (REQUIRED)
    SGG    - GAS SPECIFIC GRAVITY (W.R.T. AIR), FRACTION (DEFAULT = 0.8)

CARD R5 *****  READ INJECTION/PRODUCTION CONTROLS
  READ(IR,) FOINIT, DELTR, DELC3, QRES, WAG, HPVWSI, PVMAX
    FOINIT - INITIAL OIL CUT AT THE START OF CO2 FLOODING,
             FRACTION (DEFAULT = 0.001)
    DELTR  - TIME INCREMENT FOR RECOVERY CALCULATIONS, YEAR
             (DEFAULT = 0.5)
    DELC3  - CONCENTRATION INCREMENT USED FOR FRACTIONAL FLOW
             CALCULATIONS, FRACTION (DEFAULT = 0.001)
    QRES   - TOTAL FLUID INJECTION RATE, RB/DAY (DEFAULT:QRES=0.1*
             (1.0-SWCN)*BW*(7758.0*AREA*POROS*THICK)/365.0). DEFAULT IS
             0.1 HCPV/YR. QRES IS CONSTANT DURING RUN.
    WAG    - WAG RATIO FOR CO2 INJECTION (DEFAULT: IF (WAG.LE.0.05)
             WAG = 0.05. NOTE - DO NOT ENTER WAG.GE.30.0. CO2PM DOES NOT
             REDUCE TO WATERFLOOD AT VERY HIGH WAG RATIOS, AND MAY
             BECOME UNSTABLE IF WAG LARGE)
    HPVWSI - TOTAL HYDROCARBON PORE VOLUMES OF CO2 AND WATER INJECTED
             DURING WAG (DEFAULT = 1.0)
```

PVMAX - TOTAL PORE VOLUMES OF WAG AND CHASE WATER INJECTED
(DEFAULT = 4.0)

CARD R6 ***** READ VISCOSITY AND HETEROGENEITY DATA
READ(IR,) VWAT, VOIL, VSIC, VDP, YK, VDPL, LAYERS

VWAT - WATER VISCOSITY AT RESERVOIR CONDITIONS, CP
(DEFAULT: VWAT=EXP(1.003-1.479E-2*TRES+1.982E-5*TRES**2,
(VAN WINGEN CORRELATION, API, 1950))

VOIL - OIL VISCOSITY AT RESERVOIR CONDITIONS, CP
(DEFAULT: SEE SECTION 3.1)

VISC - CO2 VISCOSITY AT RESERVOIR CONDITIONS, CP
(DEFAULT: CALCULATED INTERNALLY AT RES. T, P FROM TABLES
IN SUBROUTINE PROPC (MICHELS ET AL, 1957))

VDP - DYKSTRA-PARSONS COEFFICIENT FOR RESERVOIR HETEROGENEITY
FOR USE WITHIN EACH LAYER. (DEFAULT: IF VDP .LE. 0.0,
MODEL COMPUTES A D-P COEFFICIENT FOR EACH LAYER FROM VDPL
ENTERED BELOW). IF VDP .GT. 0.0, THEN SINCE VDP IS READ
ONLY ONCE, VDP WILL BE THE SAME IN EACH LAYER, AND WILL BE
USED TO CALCULATE YK FOR EACH LAYER (SEE BELOW).

YK - KOVAL FACTOR WITHIN INDIVIDUAL LAYERS. MAY BE READ IN, OR
CALCULATED INTERNALLY BY TWO METHODS. METHOD 1): IF
VDP .GT. 0.0 ABOVE AND YK .LE. 0.0, MODEL USES VDP TO
CALCULATE YK, WHICH WILL BE THE SAME IN EACH LAYER.
METHOD 2): IF VDP .LE. 0.0 ABOVE AND YK .LE. 0.0, MODEL
USES VDPL (BELOW) TO CALCULATE YK FOR EACH LAYER. IF
VDPL .GT. 0.0, THEN YK WILL BE DIFFERENT IN EACH LAYER.
FOR EITHER METHOD, YK=H*E*FACT, WHERE H IS A FUNCTION
OF VDP (OR VDPL), E IS CALCULATED FROM THE QUARTER-POWER
MIXING RULE, AND FACT IS A FACTOR TO ACCOUNT FOR GRAVITY
OVERRIDE. SEE SECTION 1.3 FOR DETAILS OF CALCULATIONS.
IF VDP (OR VDPL) = 0.0, H = 1.0 AND YK=E*FACT. FOR 1-D AND
2-D (IRES=1 OR 2 ON CARD R2) FACT= 1.0 (NO GRAVITY OVER-
RIDE). FOR 3-D (IRES=3), IF XKVH .GT. 0.0 (CARD R4),
THEN FACT >1 WILL BE USED TO MODIFY READ IN OR CALCULATED
YK. IF XKVH .LE. 0.0, FACT = 1.0. WHETHER READ IN OR
CALCULATED, FINAL YK IS BOUNDED FROM BELOW BY 1.5. IF YK
READ IN .GT. 0.0, THEN YK WILL BE THE SAME IN EACH LAYER.
WARNING: IF A VALUE OF YK .GT. 0.0 IS READ IN THAT IS NOT
CLOSE TO THE YK WHICH WOULD BE CALCULATED FROM THE OIL/CO2
VISCOSITY RATIO, ERRORS IN THE FRACTIONAL FLOW CALCULATION
MAY RESULT. RECOMMEND PROCEDURE: ENTER VDP = 0.0 ABOVE,
YK= 0.0, AND VDPL >0 BELOW.

VDPL - DYKSTRA-PARSONS COEFFICIENT FOR RESERVOIR HETEROGENIETY
AMONG ALL LAYERS (NO DEFAULT; SUGGESTED VALUE = 0.72).
VDPL IS A MEASURE OF HETEROGENIETY AMONG GROSS LAYERS.
VDPL IS USUALLY OBTAINED FROM THE RESULTS OF WATERFLOOD
PERFORMANCE. VDPL IS USED IN THE CO2PM TO BACK CALCULATE
(SUBROUTINE LMULT) THE PERMEABILITIES OF INDIVIDUAL
LAYERS (OF EQUAL THICKNESS = THICK /LAYERS, WHERE THICK
IS READ IN ON CARD R3 AND THE NUMBER OF LAYERS IS READ
IN BELOW), ASSUMING THE LAYER PERMEABILITIES HAVE A LOG-

```
              NORMAL DISTRIBUTION, AND THE AVERAGE PERMEABILITY IS PERM
              (CARD R3). TOTAL INJECTION RATE (QRES, CARD R5) AND SLUG
              SIZE (HPVWSI, CARD R5) ARE THEN ALLOCATED AMONG THE LAYERS
              ACCORDING TO PERMEABILITY. IF VDPL .LE. 0.0 IS ENTERED,
              THEN ALL LAYERS WILL HAVE THE SAME PERMEABILITY. SEE
              SECTION 1.7 FOR DETAILS.
    LAYERS - NUMBER OF LAYERS (1 TO 5) OF THICKNESS = THICK/LAYERS AND
              HETEROGENEITY VDPL (DEFAULT = 1)

CARD R7 *****  READ RELATIVE PERMEABILITY DATA
        (NOTE: SEE TABLE 2-3 FOR RELATIVE PERMEABILITY RELATIONSHIPS)
  READ(IR,) XNO, XNW, XKROE, XKRWE, SWCN, SORW
    XNO    - EXPONENT FOR OIL RELATIVE PERMEABILITY CURVE (DEFAULT=2.0)
    XNW    - EXPONENT FOR WATER RELATIVE PERMEABILITY CURVE(DEFAULT=2.0)
    XKROE  - RELATIVE PERMEABILITY TO OIL AT CONNATE WATER SATURATION
             (DEFAULT = 1.0)
    XKRWE  - RELATIVE PERMEABILITY TO WATER AT RESIDUAL OIL SATURATION
             (DEFAULT = 0.2)
    SWCN   - CONNATE WATER SATURATION, FRACTION (DEFAULT = 0.2)
    SORW   - RESIDUAL OIL SATURATION TO WATER, FRACTION (DEFAULT = 0.2)

CARD R8 ***** READ END CARD (READ ONLY IF IECON = 0 ON CARD R2)
  READ (IR,) END
    END - "END " IN COLUMNS 1-4
```

2.2 ECONOMIC DATA

```
THE FOLLOWING CARDS ARE TO BE READ IF IECON =1 ON CARD R2

CARD E1 ***** READ TITLE
  READ(IR,) TITLE
    MAY BE UP TO 80 ALPHA-NUMERIC CHARACTERS

CARD E2 ***** READ CASE CONTROLS
  READ(IR,) M,ISTATE,IDIST,IOUT2,IFIT,IDAT,NCT,NCI,IDISC,
            ISO,ICO2,IPLIF,IYPL,IYCS,IDEBT

    M      - NUMBER OF YEARS IN THE PROJECT (FOR ALL PATTERNS)
             M MUST BE .LE. 50
    ISTATE - STATE CODE. USED TO DEFAULT WELL CAPITAL COSTS
             (DRILLING, COMPLETION, CONVERSION, UPGRADING)
             BY REGION OF U.S. SEE SECTION 3.2 FOR EXPLANATION OF
             OF DEFAULTS BY REGION. TO INVOKE DEFAULTS FOR WELL
             CAPITAL COSTS, ENTER THE APPROPRIATE NUMBER 1-52 FROM THE
             TABLE BELOW, AND WPP'S AS REQUIRED ON CARD E4.
```

CODE	ALPHA	STATE	CODE	ALPHA	STATE
1	AL	ALABAMA	27	NV	NEVADA
2	AZ	ARIZONA	28	NH	NEW HAMPSHIRE
3	AR	ARKANSAS	29	NJ	NEW JERSEY
4	CA	CALIFORNIA	30	NM	NEW MEXICO
5	CO	COLORADO	31	NY	NEW YORK
6	CT	CONNECTICUT	32	NC	N.CAROLINA
7	DE	DELAWARE	33	ND	N.DAKOTA
8	DC	WASH D.C.	34	OH	OHIO
9	FL	FLORIDA	35	OK	OKLAHOMA
10	GA	GEORGIA	36	OR	OREGON
11	ID	IDAHO	37	PA	PENNSYLVANIA
12	IL	ILLINOIS	38	RI	RHODE ISLAND
13	IN	INDIANA	39	SC	S.CAROLINA
14	IA	IOWA	40	SD	S.DAKOTA
15	KS	KANSAS	41	TN	TENNESSEE
16	KY	KENTUCKY	42	TX	TEXAS
17	LA	LOUISIANA	43	UT	UTAH
18	ME	MAINE	44	VT	VERMONT
19	MD	MARYLAND	45	VA	VIRGINIA
20	MA	MASS	46	WA	WASHINGTON
21	MI	MICHIGAN	47	WV	WEST VIRGINIA
22	MN	MINNESOTA	48	WI	WISCONSIN
23	MS	MISSISSIPPI	49	WY	WYOMING
24	MO	MISSOURI	50	AK	ALASKA
25	MT	MONTANA	51	HI	HAWAII
26	NE	NEBRASKA	52	PO	OFFSHORE

TO DISABLE DEFAULTS FOR WELL COSTS, ENTER WPP1=WPP2=WPP3=WPP4=0.0 ON CARD E4. THEN WELL COSTS MAY, IF DESIRED, BE ENTERED AS PART OF CAPITAL COSTS ON CARDS E20-E21. IF WPP'S=0.0 ON CARD E4 AND ISTATE = 1-52 ON THIS CARD, THEN MODEL PENALIZES OIL PRICE BASED ON API GRAVITY AND LOCATION. SEE SECTION 3.2 FOR EXPLANATION OF PENALITIES. IF PROJECT IS OUTSIDE U.S. OR IT IS DESIRED TO DISABLE OIL PRICE PENALTY, ENTER WPP'S = 0.0 ON CARD E4 AND ISTATE = 53 ON THIS CARD. NOTE: IF ISTATE = 53 SELECTED, USER MUST ENTER WPP'S = 0.0 ON CARD E4.

IDIST - DISTRICT CODE (WITHIN A STATE). USED TO DEFAULT WELL COSTS. SEE SECTION 3.2 FOR DEFAULTS. IF OUTSIDE U.S. OR IF ISTATE= 53, ENTER IDIST=0. FOR TEXAS RAILROAD COMMISSION (RRC) DISTRICTS, ENTER (RRC NO. * 10) + Y, WHERE

Y = 1 FOR A
= 2 FOR B
= 3 FOR C

EG., FOR DISTRICT 10B ENTER 102, ETC.

IOUT2 - CONTROLS PRINTING OF RESULTS OF ECONOMIC CALCULATIONS
(NO DEFAULT, SEE TABLE 2-2 AND SECTION 4.1)
= 0, MINIMUM OUTPUT, PRINTS ECONOMIC SUMMARY
= 1, ALSO PRINTS ANNUAL CASH FLOW AND PROJECT CAPITAL SCHEDULE
= 2, ALSO PRINTS UNDISCOUNTED RESULTS, DCF CALCULATIONS, AND ESCALATED VALUES OF PRICES AND COSTS

IFIT - FEDERAL INCOME TAX CREDIT OPTION (NO DEFAULT)
= 0, ALLOWS A TAX CREDIT TO OFFSET LOSSES
= 1, NO TAX CREDIT ALLOWED

IDAT - CONTROL FOR READING PRICE AND COST DATA
= 0, DEFAULT PRICES AND COSTS USED, SKIP CARDS E14-E19; SEE E14-E19 FOR DEFAULT VALUES
= 1, READ CARDS E14-E19 FOR PRICE AND COST DATA

NCT - CONTROL FOR READING TANGIBILE CAPITAL INVESTMENT PER PATTERN IN ANY GIVEN YEAR. INVESTMENTS WILL BE TIMED ACCORDING TO PATTERN SCHEDULE ON CARD E13.
= 0, DO NOT READ TANGIBLE CAPITAL INVESTMENT ON CARD E20
= 1, READ TANGIBLE CAPITAL INVESTMENT ON CARD E20

NCI - CONTROL FOR READING INTANGIBLE CAPITAL INVESTMENT PER PATTERN IN ANY GIVEN YEAR. INVESTMENTS WILL BE TIMED ACCORDING TO PATTERN SCHEDULE ON CARD E13.
= 0, DO NOT READ INTANGIBLE CAPITAL INVESTMENT ON CARD E21
= 1, READ INTANGIBLE CAPITAL INVESTMENT ON CARD E21

IDISC - CONTROL FOR DISCOUNTING METHOD (NO DEFAULT)
= 0, YEAR END DISCOUNTING FACTORS USED
= 1, MID-YEAR DISCOUNTING FACTORS USED

ISO - CONTROL FOR READING SECONDARY OIL VOLUMES (NO DEFAULT)
= 0, DO NOT READ SECONDARY OIL VOLUMES
= 1, READ SECONDARY OIL VOLUMES ON CARD E9

ICO2 - CONTROL FOR CO2 PLANT TYPE (NO DEFAULT). SEE SECTION 3.2 FOR DEFAULT EQUATIONS FOR CO2 PLANTS.
= 0: TYPE 1 PLANT FOR SEPARATION OF CO2, RECYCLE OF PURE CO2, DEHYDRATION AND SALE OF GAS, AND PROCESSING TO RECOVER NGL, BUT NO EXCESS CO2 RESALE.
= 1: TYPE 1 PURIFICATION PLANT AS ABOVE WITH SALE OF GAS AND EXCESS CO2 RESALE.
= 2: TYPE 2 COMPRESSION PLANT FOR RECYCLE OF TOTAL PRODUCED GAS (SOLN. GAS AND CO2) STREAM, NO GAS SOLD AND NO CO2 RESALE.
= 3: NO CO2 PLANT, NO CO2 RECYCLE, NO GAS SOLD, AND NO CO2 RESALE.
NOTE: MODEL CONVERTS TYPE 1 PLANT TO TYPE 2 PLANT IF MAXIMUM TOTAL GAS RATE .LT. 5.0 MMCF/D.

IPLIF - CONTROL ON ECONOMIC LIFE (NO DEFAULT)
= 0, ECONOMIC LIFE BASED ON AFTER TAX CASH FLOW
= 1, ECONOMIC LIFE BASED ON NET OPERATING INCOME

IYPL - YEAR IN WHICH PIPELINE CAPITAL SPENT (DEFAULT = YEAR 1)

IYCS - YEAR IN WHICH CO2 RECYCLE PLANT CAPITAL SPENT (DEFAULT = YEAR 1)

```
    IDEBT  - CONTROL ON DEBT CALCULATIONS (NO DEFAULT)
             = 0, NO CAPITAL BORROWING DEBT CALCULATIONS
             = 1, INCLUDE CAPITAL BORROWING BASED ON DATA INPUT
                  ON CARD E3

CARD E3 ***** READ DEBT CONTROLS (READ IF IDEBT = 1 ON CARD E2)
  READ(IR,) PCTDBT,DBTINT,NYRRPY,NYPAID
    PCTDBT - PERCENT OF CAPITAL (TANGIBLE AND INTANGIBLE) COSTS
             TO BE BORROWED, PERCENT (DEFAULT=20.)
    DBTINT - DEBT INTEREST RATE, PERCENT (DEFAULT=15.)
    NYRRPY - NUMBER OF YEARS BEFORE BEGINNING DEBT REPAYMENT
             (DEFAULT=1.)
    NYPAID - NUMBER OF YEARS BEFORE COMPLETING DEBT REPAYMENT
             (DEFAULT=5.)

CARD E4 ***** READ DRILLING DATA
  READ(IR,) WPP1,WPP2,WPP3,WPP4
            (ENTER ALL ZEROS IF WELL CAPITAL COSTS INCLUDED ON CARDS
            E20-E21. SEE SECTION 3.2 FOR WELL CAPITAL COSTS DEFAULT
            EQUATIONS USING WPP'S.)
    WPP1 - NUMBER OF INJECTORS DRILLED PER PATTERN (NO DEFAULT)
    WPP2 - NUMBER OF PRODUCERS DRILLED PER PATTERN (NO DEFAULT)
    WPP3 - NUMBER OF PRIMARY PRODUCERS CONVERTED TO SECONDARY PRODUCERS
           PER PATTERN (NO DEFAULT)
    WPP4 - NUMBER OF EXISTING PRODUCERS CONVERTED TO INJECTORS
           PER PATTERN (NO DEFAULT)

CARD E5 ***** READ OPERATING AND PLANT CAPITAL DATA
       CAPITAL FOR CO2 RECYCLE PLANT (CSEP) ON THIS CARD WILL BE SPLIT
       INTO TWO PLANTS OF ONE-HALF TOTAL REQUIRED CAPACITY WHEN THE
       MAXIMUM COMBINED PRODUCED GAS RATE, TMAX (CO2 + HYDROCARBON GAS)
       EXCEEDS 60 MMCF/D. THE FIRST PLANT WILL BE TAKEN IN YEAR IYCS
       (CARD E2), THE SECOND FIVE YEARS LATER. CSEP IS A FUNCTION OF
       PLANT TYPE (ICO2 ON CARD E2) AND TMAX. SEE SECTION 3.2 FOR
       DETAILS OF CSEP DEFAULTS.
  READ(IR,) CSEP,CSCAP,WOCOST,WTCOST
    CSEP   - CAPITAL FOR CO2 RECYCLE PLANT, M$ (DEFAULT:SEE SECTION 3.2)
    CSCAP  - CAPACITY OF RECYCLE PLANT, MMCF/D (DEFAULT: CALCULATED
             INTERNALLY AS 0.75*TMAX. IF CSEP.GT.0.0 IS ENTERED ABOVE,
             MODEL AUTOMATICALLY TAKES DEFAULT FOR CSCAP.
    WOCOST - ANNUAL WELL WORKOVER COST PER PATTERN, M$
             (DEFAULT: 0.25*CNVT. ASSUMES ONE WORKOVER PER PATTERN
             EVERY FOUR YEARS. CNVT IS THE COST TO CONVERT AN EXISTING
             PRODUCER TO AN INJECTION WELL. SEE SECTION 3.2 FOR DEFAULT
             FOR CNVT.)
    WTCOST - PRODUCED WATER TREATING AND INJECTION COST, $/BBL
             (DEFAULT=0.03)
```

```
CARD E6 ***** READ OPERATING DATA
  READ(IR,) WCAP, UNCO, COSTRT
    WCAP   - MONTHS OF WORKING CAPITAL, MONTHS (NO DEFAULT)
    UNCO   - OIL RATE UNCERTAINTY, FRACTION (DEFAULT= 0.001)
    COSTRT - PROJECT STARTUP COSTS, M$ (NO DEFAULT; THE NEGATIVE OF
             COSTRT IS USED TO INITIALIZE CASH FLOW)

CARD E7 ***** READ PIPELINE DATA
  READ(IR,) CPIPL,PIPEL,PCAP,PDPM,PFOC
    CPIPL - PIPELINE CAPITAL, M$ (NO DEFAULT) RECOMMENDED VALUE:
            PIPEL*PDPM. CPIPL WILL BE TAKEN AS TANGIBLE CAPITAL IN
            YEAR IYPL (CARD E2)
    PIPEL - LENGTH OF PIPELINE, MILES (NO DEFAULT)
    PCAP  - PIPELINE CAPACITY, MMCF/DAY (NO DEFAULT)
    PDPM  - UNIT COST OF CO2 PIPELINE (AT ANY CAPACITY), M$/MILE
            (NO DEFAULT; RECOMMENDED VALUE: 100.0+2.008*PCAP**0.834,
            DOE, 1981). FOR RUGGED TERRAIN, ADD 290.0 M$/MI; ROLLING
            HILLS ADD $16,500/MI; RIVER CROSSINGS ADD 330.0 M$/MI;
            AND FOR ELEVATION CHANGE, ADD $2,100/FT.
    PFOC  - PIPELINE FIXED OPERATING COST, M$/MILE/YR (NO DEFAULT).
            USED TO COMPUTE FIXED OPERATING COST FOR PIPELINE (M$/YR)
            FOPIP=PFOC*PIPEL. FOPIP IS ROLLED-UP WITH THE FOCM(I) ON
            CARD E17 EACH YEAR OF THE PROJECT TO GIVE TOTAL FIXED
            OPERATING COST.

CARD E8 ***** READ RELEASED OIL DATA
        (NOTE: NOT USED IF XWPT=0.0 ON CARD E11, I.E., NO OIL RELEASED
        FROM WINDFALL PROFIT TAX IF WPT RATE IS ZERO)
  READ(IR,) OILB,OILC,DECL
    OILB - 1979 PROJECT BASE OIL RATE, MMBL/YR (DEFAULT = 0.)
    OILC - CURRENT NON-TERTIARY PROJECT OIL RATE, MBBL/YR
           (DEFAULT = OILB * (1.-DECL)**(BTIM-1979.))
    DECL - ANNUAL OIL PRODUCTION DECLINE RATE, PERCENT (DEFAULT = 15.)

CARD E9 ***** READ SECONDARY OIL PRODUCTION CURVE
        (READ IF ISO = 1 ON CARD E2. NOTE: NOT USED IF XWPT=0.0 ON
        CARD E11)
  READ(IR,) (VOS(I),I=1,M)
    VOS - VOLUME OF SECONDARY OIL PER PATTERN EACH YEAR, MBBL/YR
          (NOTE: IF ISO=0, MODEL DEFAULTS VOS(I)=OILC*
          (1.-DECL)**(FLOAT(I)-0.5); TO OBTAIN VOS(I)=0.0,
          SET OILB=0.0 ON CARD E8)

CARD E10 ***** READ TAXES AND MONETARY DATA
  READ(IR,) XDR,XINF,XROY,XSEV,XFIT,XTCR,DTIM,XSTX
    XDR  - MONETARY DISCOUNT RATE (DEFAULT= 0.1)
    XINF - INFLATION RATE (NO DEFAULT)
    XROY - ROYALTY RATE (NO DEFAULT)
    XSEV - SEVERANCE TAX RATE (NO DEFAULT)
    XFIT - FEDERAL INCOME TAX RATE (NO DEFAULT)
```

```
    XTCR - INVESTMENT TAX CREDIT (NO DEFAULT)
    DTIM - INVESTMENT DEPRECIATION TIME, YR (NO DEFAULT)
           IF DTIM = 0.0, MODEL USES ACCELERATED CAPITAL RECOVERY
           SYSTEM (5 YEAR DEPRECIATION) ACCORDING TO 1981 TAX ACT
           (SEE TABLE 2-4). IF DTIM .GT. 0.0, USES STRAIGHT LINE
           DEPRECIATION FROM YEAR OF INVESTMENT OVER DTIM YEARS.
    XSTX - STATE INCOME TAX RATE (NO DEFAULT)

CARD E11 ***** READ WINDFALL EXCISE (PROFIT) TAX DATA
  READ(IR,) XWPT,WPHO,EPHO,BTIM,BPOW
    XWPT - WINDFALL EXCISE TAX RATE. IF 0.0 THEN IGNORES TAX.
           SEE SECTION 3.2 AND TABLE 3-7 FOR EXPLANATION OF WINDFALL
           EXCISE TAX.
    WPHO - WINDFALL TAX BEGINNING PHASE OUT DATE (DEFAULT= 1991.)
    EPHO - WINDFALL TAX ENDING PHASE OUT DATE (DEFAULT= 1993.)
    BTIM - BASE TIME FOR PROJECT START (DEFAULT= 1985.)
    BPOW - BASE OIL PRICE AT START OF PROJECT FOR WPT CALCULATIONS
           ONLY, $/BBL (DEFAULT= 23.07*(1.+XINF)**(BTIM-1983.)
           NOTE: OIL PRICE FOR SALES AND REVENUE PURPOSES IS ENTERED OR
           DEFAULTED ON CARD E14)

CARD E12 ***** READ ESCALATION DATA
  READ(IR,) ESCPO,ESCPG,ESCPI,ESCFO,ESCTR,ESCCT,ESCCI,ESCWO
    ESCPO - ESCALATION RATE OF OIL PRICE (NO DEFAULT)
    ESCPG - ESCALATION RATE OF GAS PRICE (NO DEFAULT)
    ESCPI - ESCALATION RATE OF CO2 PRICE (NO DEFAULT)
    ESCFO - ESCALATION RATE OF OPERATING COSTS (NO DEFAULT)
    ESCTR - ESCALATION RATE OF CO2 TREAT/RECYCLE COST (NO DEFAULT)
    ESCCT - ESCALATION RATE OF TANGIBLE CAPITAL (NO DEFAULT)
    ESCCI - ESCALATION RATE OF INTANGIBLE CAPITAL (NO DEFAULT)
    ESCWO - ESCALATION RATE OF WELL WORKOVER COST (NO DEFAULT)

CARD E13 ***** READ PROJECT PATTERN SCHEDULE
  READ(IR,) (PATI(I),I=1,M)
    PATI(I) - NUMBER OF PATTERNS INITIATED EACH YEAR OF THE PROJECT
              (NO DEFAULT)

-----------------------------------------------------------------
IF IDAT=0 ON CARD E2, MODEL USES DEFAULT PRICES AND COSTS; SKIP TO
CARD E20
-----------------------------------------------------------------

      IN ALL OF THE FOLLOWING ARRAYS, THE LAST LETTER (H, M, OR L)
 MEANS HIGH, MOST LIKELY, OR LOW VALUE OF THE PARAMETER IN A
 GIVEN YEAR.  THE HIGH AND LOW VALUES SHOULD BE CHOSEN TO
 REPRESENT A CONFIDENCE LEVEL OF 80 PERCENT.  LOW PRICE HAS A 90%
 CHANCE OF BEING OBTAINED, AND THE HIGH PRICE HAS ONLY A 10%
 CHANCE OF BEING REACHED. SEE SECTION 1.8 FOR DISCUSSION OF RISK.
```

PRICES AND COSTS, WHETHER ENTERED OR DEFAULTED, ARE SCALED BY PROGRAM (SUBROUTINE ECFTR) DUE TO VARIATION IN OIL PRICE FROM $30.00/BBL. THE PRICE FACTOR IS FACT=(POM(1)-30.00)/30., WHERE POM(1) IS ENTERED OR DEFAULTED ON CARD E14. THEN:

DRILLING AND COMPLETION FACTOR = 1.0 +(0.4 * FACT)
EQUIPMENT FACTOR = 1.0 +(0.3 * FACT)
OPERATING COSTS FACTOR = 1.0 +(0.2 * FACT)
CO2 PRICE FACTOR = 1.0 + (0.6 * FACT)
OIL PRICE FACTOR = 1.0 + FACT

(NOTE: IF ISTATE =53 (CARD E2), FACT = 0.0)

CARD E14 ***** READ OIL PRICE DATA
READ(IR,) POL(1),POM(1),POH(1)
POL(1) - LOW OIL PRICE, $/BBL (DEFAULT= POM(1) * 0.8; DEFAULT IS ALWAYS TAKEN)
POM(1) - MOST LIKELY OIL PRICE, $/BBL (DEFAULT= 30.00). THIS READ OR DEFAULTED OIL PRICE MAY SUBSEQUENTLY BE REDUCED BASED ON API GRAVITY AND LOCATION. SEE SECTION 3.2 FOR DISCUSSION OF OIL PRICE PENALTIES.
POH(1) - HIGH OIL PRICE, $/BBL (DEFAULT = POM(1) *1.2; DEFAULT IS ALWAYS TAKEN)

CARD E15 ***** READ GAS PRICE DATA
READ(IR,) PGL(1),PGM(1),PGH(1)
PGL(1) - LOW GAS PRICE, $/MCF (DEFAULT = PGM(1)*0.8)
PGM(1) - MOST LIKELY GAS PRICE, $/MCF (DEFAULT = POM(1) / 6.0)
PGH(1) - HIGH GAS PRICE, $/MCF (DEFAULT = PGM(1) * 1.2)

CARD E16 ***** READ CO2 PRICE DATA
READ(IR,) PIL(1),PIM(1),PIH(1)
PIL(1) - LOW CO2 PRICE, $/MCF (DEFAULT = 1.50)
PIM(1) - MOST LIKELY CO2 PRICE, $/MCF (DEFAULT = 2.00)
PIH(1) - HIGH CO2 PRICE, $/MCF (DEFAULT = 2.50)

CARD E17 ***** READ FIXED ANNUAL OPERATING COST DATA
(INCLUDES MAINTENANCE, OTHER COSTS THAT DO NOT DEPEND ON OIL RATE.)
READ(IR,) FOCL(1),FOCM(1),FOCH(1)
FOCL(1) - LOW FIXED OPERATING COST PER PATTERN, $/YR (DEFAULT: FOCL(1)=(CDAO+CIWO)*0.8, WHERE CDAO (OPER COSTS FOR SEC RECOVERY) AND CIWO (ADDITIONAL OPER COSTS FOR OFFSHORE WAT INJ PLANT) ARE DEFAULTED IN SECTION 3.2)
FOCM(1) - MOST LIKELY FIXED OPERATING COST PER PATTERN, $/YR (DEFAULT: FOCM(1)=(CDAO+CIWO))
FOCH(1) - HIGH FIXED OPERATING COST PER PATTERN, $/YR (DEFAULT: FOCH(1)=(CDAO+CIWO)*1.2)

```
CARD E18 ***** READ VARIABLE ANNUAL OPERATING COST DATA
         (INCLUDES LIFTING AND OTHER COSTS THAT DEPEND ON OIL PRODUCTION
          DIRECTLY, BUT NOT ROYALTY OR SEVERANCE)
  READ(IR,) OPCL(1),OPCM(1),OPCH(1)
    OPCL(1) - LOW VARIABLE OPERATING COST, $/BBL OIL PRODUCED
              (DEFAULT= 0.40)
    OPCM(1) - MOST LIKELY VARIABLE OPERATING COST, $/BBL OIL PRODUCED
              (DEFAULT= 0.50)
    OPCH(1) - HIGH VARIABLE OPERATING COST, $/BBL OIL PRODUCED
              (DEFAULT= 0.60)

CARD E19 ***** READ CO2 TREATING/RECYCLING COST DATA
  READ(IR,) TRPL(1),TRPM(1),TRPH(1)
    TRPL(1) - LOW CO2 TREAT/RECYCLE COST, $/MCF (DEFAULT = TRPM(1)*0.8;
              DEFAULT IS ALWAYS TAKEN)
    TRPM(1) - MOST LIKELY CO2 TREAT/RECYCLE COST, $/MCF (DEFAULT :
              CALCULATED INTERNALLY BASED ON TYPE OF CO2 PLANT. SEE
              SECTION 3.2. WHEN DEFAULTED, TRPM(1) WILL NOT EXCEED
              0.30. IF NO CO2 PLANT (ICO2=3 ON CARD E2), DEFAULT FOR
              TRPM(1) IS 0.0, AND IN THIS CASE A VALUE GREATER THAN
              0.30 CAN BE USED.)
    TRPH(1) - HIGH CO2 TREAT/RECYCLE COST, $/MCF (DEFAULT= TRPM(1)*1.2;
              DEFAULT IS ALWAYS TAKEN)

CARD E20 ***** READ TANGIBLE CAPITAL INVESTMENT (READ IF NCT=1
         ON CARD E2)
         (FLOW LINES, WELLS, ROADS, AND PRODUCTION FACILITIES.)
         IF WELLS ENTERED ON CARD E4, DO NOT ENTER WELL CAPITAL
         COSTS ON THIS CARD.
  READ(IR,) ICT,CTPL,CTPM,CTPH
    ICT  - ENTER 1.0
    CTPL - LOW TANGIBLE CAPITAL COST PER PATTERN, $ (NO DEFAULT)
    CTPM - MOST LIKELY TANGIBLE CAPITAL COST PER PATTERN, $ (NO DEFAULT)
    CTPH - HIGH TANGIBLE CAPITAL COST PER PATTERN, $ (NO DEFAULT)

CARD E21 ***** READ INTANGIBLE CAPITAL INVESTMENT (READ IF NCI=1
         ON CARD E2)
         (CAPITAL EXPENSED IN A GIVEN YEAR.)  IF WELLS ENTERED ON
         CARD E4, DO NOT ENTER WELL CAPITAL COSTS ON THIS CARD.
  READ(IR,) ICI,CIPL,CIPM,CIPH
    ICI  - ENTER 1.0
    CIPL - LOW INTANGIBLE CAPITAL COST PER PATTERN, $ (NO DEFAULT)
    CIPM - MOST LIKELY INTANGIBLE CAPITAL COST PER PATTERN, $
           (NO DEFAULT)
    CIPH - HIGH INTANGIBLE CAPITAL COST PER PATTERN, $ (NO DEFAULT)

CARD E22 ***** READ END CARD
  READ (IR,) END
    END - "END " IN COLUMNS 1-4

********** RETURN TO CARD R1 FOR NEW CASE ***********
```

TABLE 2-1
CO2PM DATA ENTRY

Reservoir Data

R1 TITLE
R2 IRES, IOUT, ISOL, IECON
R3 PRES, TRES, POROS, THICK, AREA, PERM, DEPTH
R4 XKVH, SALN, BO RS, BW, BCO2, API, SGG
R5 FOINIT, DELTR, DELC3, QRES, WAG, HPVWSI, PVMAX
R6 VWAT, VOIL, VISC, VDP, YK, VDPL, LAYERS
R7 XNO, XNW, XKROE, XKRWE, SWCN, SORW
R8 END (Enter only if IECON=0)

Economic Data

E1 TITLE
E2 M, ISTATE, IDIST, IOUT2, IFIT, IDAT, NCT, NCI, IDISC, ISO, ICO2, IPLIF, IYPL, IYCS, IDEBT
E3 PCTDBT, DBTINT, NYRRPY, NYPAID (ENTER IF IDEBT=1)
E4 WPP1, WPP2, WPP3, WPP4
E5 CSEP, CSCAP, WOCOST, WTCOST
E6 WCAP, UNCO, COSTRT
E7 CPIPL, PIPEL, PCAP, PDPM, PFOC
E8 OILB, OILC, DECL
E9 VOS(I), I=1, M (ENTER IF ISO=1)
E10 XDR, XINF, XROY, XSEV, XFIT, XTCR, DTIM, XSTX
E11 XWPT, WPHO, EPHO, BTIM, BPOW
E12 ESCPO, ESCPG, ESCPI, ESCFO, ESCTR, ESCCT, ESCCI, ESCWO
E13 PAT(I), I=1,M
E14 POL(1), POM(1), POH(1)
E15 PGL(1), PGM(1), PGH(1)
E16 PIL(1), PIM(1), PIH(1)
E17 FOCL(1), FOCM(1), FOCH(1)
E18 OPCL(1), OPCM(1), OPCH(1)
E19 TRPL(1), TRPM(1), TRPH(1)
E20 ICT, CTPL, CTPM, CTPH (ENTER IF NCT=0)
E21 ICI, CIPL, CIPM, CIPH (ENTER IF NCI=0)
E22 END

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Runtime Error Messages

with DOE/BC-88/1/SP
DKOlsen

Runtime error numbers are written as 4-digit decimal integers, except for Runtime DOS System Return Codes. They are split into groups according to the type of runtime routine that detects the error.

Error Numbers	Type of Runtime Routine
1000 to 1999	Intrinsic Function
2000 to 2499	I/O other than Format Control
2500 to 2999	Format Control I/O
3000 to 3999	Operating System Interface
4000 to 4999	Miscellaneous
5000 to 5999	Debug I/O
	DOS System Return Codes for Runtime

Intrinsic Functions

Unless otherwise specified, intrinsic function errors indicate that an argument is either unnormalized or Not a Number (NaN). The argument is returned unmodified. Messages with an asterisk (*) beside them apply to INTEGER*2 data; those with double asterisks (**) beside them apply to INTEGER*4 data. The asterisks do not appear in the actual message.

Number Message

1000 Incorrect ACOS argument

The argument's magnitude is greater than 1. For a negative argument, ACOS returns the value π. For a positive argument, ACOS returns the value 0.

1001 Incorrect DACOS argument

The argument's magnitude is greater than 1. For a negative argument, DACOS returns the value π. For a positive argument, DACOS returns the value 0.

1002 Incorrect ASIN argument

The argument's magnitude is greater than 1. For a negative argument, ASIN returns the value $-\pi/2$. For a positive argument, ASIN returns the value $+\pi/2$.

1003 Incorrect DASIN argument

The argument's magnitude is greater than 1. For a negative argument, DASIN returns the value $-\pi/2$. For a positive argument, DASIN returns the value $+\pi/2$.

1004 Incorrect ATAN2 arguments

Both arguments are 0. ATAN2 returns the value 0.

1005 Incorrect DATAN2 argument

Both arguments are 0. DATAN2 returns the value 0.

1006 Incorrect COSH argument

The argument's magnitude is greater than or equal to 88.7228. COSH returns the value 3.4E38.

1007 Incorrect DCOSH argument

The argument's magnitude is greater than or equal to 709.78271. DCOSH returns the value 1.79E308.

1008 Incorrect EXP argument

The argument is greater than or equal to 88.7228. EXP returns the value 3.4E38.

1009 Incorrect DEXP argument

The argument is greater than or equal to 709.78271. DEXP returns the value 1.79E308.

1010 Incorrect ALOG10 argument

The argument is less than or equal to 0. ALOG10 returns the value -3.4E38.

1011 Incorrect DLOG10 argument

The argument is less than or equal to 0. DLOG10 returns the value -1.79E308.

1012 Incorrect ALOG argument

The argument is less than or equal to 0. ALOG returns the value -3.4E38.

1013 Incorrect DLOG argument

The argument is less than or equal to 0. DLOG returns the value -1.79E308.

1014 Incorrect CLOG argument

CABS (argument) equals 0. CLOG returns the value (-3.4E38,-3.4E38).

1015 Incorrect MOD argument

The argument is 0. MOD returns the value 0.

1016 Incorrect AMOD argument

The argument is 0. AMOD returns the value 0.

1017 Incorrect DMOD argument

The argument is 0. DMOD returns the value 0.

1022 Incorrect SINH argument

The argument's magnitude is greater than or equal to 88.7228. For a negative argument, SINH returns the value -3.4E38. For a positive argument, SINH returns the value +3.4E38.

1023 Incorrect DSINH argument

The argument's magnitude is greater than or equal to 709.78271. For a negative argument, DSINH returns the value +1.79E308.

1024 Incorrect SQRT argument

The argument is negative. SQRT returns a NaN.

1025 Incorrect DSQRT argument

The argument is negative. DSQRT returns a NaN.

1026 Incorrect TAN argument

The argument's magnitude is greater than π*2**18.

1027 Incorrect DTAN argument

The argument's magnitude is greater than π*2.D0**50.

1102 Incorrect AINT argument

1104 Incorrect DINT argument

1106 Incorrect ANINT argument

1108 Incorrect DNINT argument

1110 Incorrect NINT argument *

1112 Incorrect NINT argument **

1114 Incorrect IDNINT argument *

1116 Incorrect IDNINT argument **

1121 Incorrect ABS argument

1122 Incorrect DABS argument

1124 Incorrect CABS argument

1126 Incorrect ISIGN argument *

1128 Incorrect ISIGN argument **

1130 Incorrect SIGN argument

1132 Incorrect DSIGN argument

1134 Incorrect IDIM argument *

1136 Incorrect IDIM argument **

1138 Incorrect DIM argument

1140 Incorrect DDIM argument

1142 Incorrect MAX0 argument *

1144 Incorrect MAX0 argument **

1146 Incorrect AMAX1 argument

1148 Incorrect DMAX1 argument

1150 Incorrect AMAX0 argument *

1152 Incorrect AMAX0 argument **

1154 Incorrect MAX1 argument *

1156 Incorrect MAX1 argument **

1158 Incorrect MIN0 argument *

1160 Incorrect MIN0 argument **

1162 Incorrect AMIN1 argument

1164 Incorrect DMIN1 argument

1166 **Incorrect AMIN0 argument ***

1168 **Incorrect AMIN0 argument ****

1170 **Incorrect MIN1 argument ***

1172 **Incorrect MIN1 argument ****

1174 **Incorrect LEN argument ***

1176 **Incorrect LEN argument ****

1178 **Incorrect INDEX argument ***

1180 **Incorrect INDEX argument ****

1182 **Incorrect AIMAG argument**

1184 **Incorrect CONJG argument**

1186 **Incorrect CSQRT argument**

1188 **Incorrect CEXP argument**

1190 **Incorrect SIN argument**

The argument's magnitude is greater than π*2**18.

1192 **Incorrect DSIN argument**

The argument's magnitude is greater than π*2.DO**50.

1194 **Incorrect CSIN argument**

1196 **Incorrect COS argument**

The argument's magnitude is greater than π*2**18.

1198 **Incorrect DCOS argument**

The argument's magnitude is greater than π*2.DO**50.

1200 **Incorrect CCOS argument**

1202 **Incorrect ATAN argument**

1204 **Incorrect DATAN argument**

1206 **Incorrect TANH argument**

1208 **Incorrect DTANH argument**

1210 **Incorrect ISHL argument**

1212 **Incorrect ISHA argument**

1214 **Incorrect ISHC argument**

1216 **Incorrect IBCLR argument**

1218 **Incorrect IBSET argument**

1220 **Incorrect IBCHNG argument**

1222 **Incorrect BTEST argument**

1224 **Incorrect INTEGER*2**INTEGER*2 Argument**

The value of the base is equal to 0 and the value of the exponent is less than or equal to 0. The value 1 in the correct type is returned.

1226 Incorrect INTEGER*4INTEGER*4 Argument**

The value of the base is equal to 0 and the value of the exponent is less than or equal to 0. The value 1 in the correct type is returned.

1228 Incorrect FLOATING POINTINTEGER Argument**

The value of the base is equal to 0 and the value of the exponent is less than or equal to 0. The value 1 in the correct type is returned.

1230 Incorrect FLOATING POINTFLOATING POINT Argument**

The value of the base is equal to 0 and the value of the exponent is less than or equal to 0. The value 1 in the correct type is returned.

The value of the base is less than 0 and the value of the exponent is not equal to 0.

1232 Incorrect COMPLEXFLOATING POINT Argument**

The value of the base is equal to 0 and the value of the exponent is less than or equal to 0. The value 1 in the correct type is returned.

1234 Incorrect COMPLEXCOMPLEX Argument**

The value of the base is equal to 0 and the value of the exponent is less than or equal to 0. The value 1 in the correct type is returned.

1236 Array size too large

Your program has been compiled without the /B option, but it contains arrays greater than 64K bytes.

I/O Other Than Format Control

Number Message

2000 BACKSPACE on direct access

The unit must be connected for sequential access.

2001 BACKSPACE on non-existent file

The file is connected but does not exist.

2002 BACKSPACE on unconnected unit

2003 CLOSE of scratch file with KEEP status

STATUS = 'KEEP' has been specified in a CLOSE statement that refers to a file whose status prior to execution of the CLOSE statement is 'SCRATCH'.

2004 ENDFILE on unconnected unit

2005 ENDFILE on direct access

The unit must be connected for sequential access.

2006 Formatted I/O not allowed

Formatted transfer is attempted on a unit that is connected for unformatted transfer.

2007 Incorrect BLANK argument

The BLANK argument must be 'NULL' or 'ZERO' with optional trailing blanks.

2008 Incorrect FORM argument

The FORM argument must be 'FORMATTED' or 'UNFORMATTED' with optional trailing blanks.

2009 Incorrect STATUS argument

The STATUS argument must be 'OLD', 'NEW', 'SCRATCH', or 'UNKNOWN' with optional trailing blanks.

2010 OPEN specifies BLANK with unformatted I/O

No BLANK specifier can be present when a unit is being opened for unformatted I/O.

2011 OPEN RECL too large

The RECL specifier on an OPEN statement requests a record length greater than the maximum permitted.

2012 OPEN specifies RECL with sequential access

No RECL specifier can be present when a unit is being opened for sequential access.

2013 OPEN STATUS is NEW but file exists

STATUS = 'NEW' cannot be specified when a file that already exists is being opened.

2014 OPEN STATUS is NEW but FILE not specified

A FILE specifier must be present when a file is opened with STATUS = 'NEW'.

2015 OPEN STATUS is OLD but file does not exist

A file must exist if it is to be opened with STATUS = 'OLD'.

2016 OPEN STATUS is OLD but FILE not specified

A FILE specifier must be present when a file is opened with STATUS = 'OLD'.

2017 OPEN STATUS is SCRATCH but file is named

No named file can be opened with STATUS= 'SCRATCH'.

2018 REC argument missing

A REC argument is required for a direct-access transfer.

2019 REC argument not allowed

A REC argument is not allowed for a sequential-access transfer.

2020 REWIND on unconnected unit

The unit must be connected.

2021 REWIND on direct access

The unit must be connected for sequential access.

2022 Unformatted I/O not allowed

Unformatted transfer is not allowed on a unit that is connected for formatted transfer.

2023 Unit not connected

A unit is being addressed without first having been connected by an OPEN or by preconnection.

2024 OPEN ACCESS is DIRECT but no RECL specified

A RECL must be specified for direct access.

Format Control I/O

List-directed formatting uses formatted I/O with the same effect as the format specification implied by the I/O statement's item list. It is therefore possible for list-directed formatting to cause format specification errors.

Number Message

2500 Apostrophe edit descriptor in input

An apostrophe edit descriptor cannot be used on input.

2501 Apostrophe field overflow

An apostrophe field does not fit in an output record.

2502 D or E exponent magnitude too large

The D or E output exponent is too large to fit in the space specified. Use an E*w.d*E*e* instead of an E*w.d*, or increase "E", the number of exponent digits.

2503 Format specifier exponent width too large

The sum of a format specifier's exponent width and the number of other characters required in a field is greater than the corresponding field width.

2504 Format specifier field exceeds record

A format specifier's field width overflows the corresponding record.

2505 Format specifier fraction width too large

The sum of a format specifier's fraction width and the number of other characters required in a field is greater than the corresponding field width.

2506 Format specifier integer negative

A format specifier's integer, which is required to be positive when held unsigned in a 32-bit variable, is negative when the variable is considered signed.

2507 Format specifier integer too large

A format specifier's integer has a magnitude greater than 2**31.

2508 Format specifier integer zero

A format specifier's integer is zero when it is required to be non-zero.

2509 Format specifier minimum field width too large

The sum of an I format specifier's minimum field width and the number of other characters required in a field is greater than the corresponding field width.

2510 H edit descriptor not allowed on input

An H edit descriptor cannot be used on input.

2511 Incorrect blanks edit descriptor

An edit descriptor that begins with a "B" is neither BN nor BZ.

2512 Incorrect character after format specifier field width

A "fieldwidth.fraction width" part of a D, E, F, or G field descriptor in a format specifier does not have a "." after the field width.

2514 Incorrect integer in input

An I input field does not contain a correct integer format.

2515 Incorrect format specifier item start

A format specifier item begins with an incorrect character.

2516 Incorrect format specifier start

A format specifier does not begin with a left parenthesis (after optional leading blanks).

2517 Incorrect integer character

A format specifier's integer contains an incorrect character.

2518 Incorrect logical Iolist item

A logical input field contains neither a "T" nor an "F" (preceded by optional blanks and an optional ".").

2519 Incorrect exponent in input

An F, E, D, or G input field has an incorrect exponent part.

2520 Incorrect repeated edit descriptor

A format specifier repeat count is followed by an incorrect character.

2521 Incorrect scale factor

In a "+*k*P" edit descriptor, the integer *k* is greater than 2**31-1.

2523 Internal file overflow

A transfer to or from an internal file is attempting to access beyond the end of the file.

2525 Iolist item not integer

For I output editing, the output list item must have integer type.

2526 Iolist item not logical

For L output editing, the output list item must have logical type.

2527 Iolist item neither real nor double

For F, E, D, and G editing, the input or output list item must have real, double-precision, or complex type.

2528 P missing in format specifier

An edit descriptor that begins with a signed integer does not have a "P" after the integer.

2529 Premature end of format specifier

A format specifier has too few right parentheses to match its left parentheses.

2530 Read after end of field

A formatted input operation is attempting to read more characters than are in the specified field.

2531 Record integer too large

An I input integer's magnitude is greater than 2**31.

2532 Record position too high

A transfer is being attempted when the record position is greater than the record length. This can be due to the use of T, TR, or X edit descriptors, or by reading more characters than the record contains, or by writing more characters than the record can contain.

2533 Repeat count zero

A format specifier contains a zero repeat count. It must be 1 or more.

2534 Scale factor too large

In a D, E, or G output, the fraction width (*d*) is strictly positive and the scale factor must be less than *d+2*.

2535 Scale factor too small

In a D, E, or G output, the fraction width (*d*) is negative, and the scale factor is not greater than *-d*.

2536 Separator missing in format specifier

A comma or a slash separator is missing between a format specifier's items.

2537 Too many parentheses in format specifier

More than nine pairs of parentheses in a format specifier have had to be processed.

2539 Write after ENDFILE

An attempt has been made to write to a file that is positioned at the end of file.

2540 Incorrect hexadecimal in input

A Z input field does not contain a valid hexadecimal character.

2541 Incorrect character constant in list-directed input

2542 **Incorrect complex constant in list-directed input**

2543 **List-directed output field too large**

2544 **Separator missing in list-directed input**

2545 **Premature end of list-directed input record**

Operating System Interface

Number Message

3000 **Memory allocation failure**

DOS has no memory to satisfy the request for additional working space.

3001 **Backspace on wrongly positioned formatted file**

DOS is unable to operate on the file that is to be backspaced.

3002 **Backspace unable to find preceding formatted record**

DOS is unable to find the record that is to be backspaced.

3003 **Backspace unable to read preceding formatted record**

DOS has indicated a reading error during backspacing.

3004 **Formatted backspace unable to complete**

Backspacing has failed to position the file according to IBM Professional FORTRAN rules.

3005 **Backspace on wrongly positioned unformatted file**

DOS is unable to operate on the file that is to be backspaced.

3006 **Backspace unable to find preceding formatted record**

3007 **Backspace unable to read unformatted record's trailer**

DOS is unable to read the backspaced record's 4-byte trailer.

3008 **Unformatted backspace unable to complete**

Backspacing has failed to position the file according to IBM Professional FORTRAN rules.

3009 **Invalid file handle for CLOSE**

3010 **Invalid file handle for DELETE**

3011 **File deletion failure**

DOS has indicated an error on an attempt to erase a file.

3012 **File opening failure**

DOS has indicated an error on an attempt to create a file.

3013 **Formatted direct record length 1 not found**

3014 **Read error on formatted direct record length 1**

3015 **Formatted direct record not found**

3016 **Read error on formatted direct record**

3017 **Unformatted direct record not found**

3019 **Read error on unformatted sequential record's header**

3020 **Read error on unformatted sequential record**

3023 **End of file before newline on reading formatted sequential record**

A "newline" in this context is either a carriage return/line feed pair or an end-of-file marker.

3024 **Formatted sequential input record too long**

An attempt has been made to read a formatted sequential record whose length is greater than the permitted maximum.

3025 **Rewind failure**

DOS is unable to position the file to offset 0.

3026 **Unable to position to write formatted direct record length 1**

3027 **Write error on formatted direct record length 1**

3028 **Unable to position to write formatted direct record**

3029 **Write error on formatted direct record**

3030 **Unable to position to write unformatted direct record**

3032 **Write error on printer control characters**

3033 Write error on formatted sequential record

3035 No workspace for filename

DOS has no memory to satisfy the request for workspace in which to construct a filename.

3036 Error in releasing default filename's storage space to operating system

An error occurred during the release of a default filename's storage space to DOS.

3037 Undefined unit for operating system interface

An attempt has been made to delete information concerning a nonexistent unit from tables.

3038 Too many units for operating system interface

An attempt has been made to register information about too many units in tables.

3039 Undefined unit for operating system interface

An attempt has been made to access information concerning a nonexistent unit in its tables.

3040 Read error in PAUSE processing

Error reading user commands during PAUSE statement execution.

3041 Unable to position after reading unformatted direct record

3042 **Unable to position to read unformatted sequential record's trailer**

An unformatted sequential record has been read according to the length found in the 4-byte header, but the file cannot be positioned to read the 4-byte trailer.

3043 **Read error on unformatted sequential record's trailer**

3044 **Unformatted sequential record length error**

An unformatted sequential record has been read according to the length found in the 4-byte header, but the 4-byte trailer does not match the header.

3045 **Unable to position to write unformatted direct record**

3046 **Attempt to read beyond the end of an unformatted record**

3047 **Read error on unformatted record**

3048 **Unable to position to write an unformatted sequential record**

3049 **Write error on unformatted sequential record's header**

3050 **Attempt to write beyond the end of an unformatted record**

3051 **Write error on unformatted record**

3052 **Write error on unformatted sequential record's trailer**

3053 Unable to position to write unformatted sequential record's header

After writing an unformatted sequential record, the file is positioned back to the record's start in order to write a 4-byte header.

3054 Write error on unformatted sequential record's header

After writing an unformatted sequential record, the file is positioned back to the record's start in order to write a 4-byte header.

3055 Unable to position after writing unformatted sequential record

After writing an unformatted sequential record, the file is positioned back to the record's start, a 4-byte header is written, and the file is positioned forwards in preparation for writing the next record.

3070 Error in reading PSP's parameter area

The Program Segment Prefix (PSP), read during program initialization to find the maximum record length parameter (/R n), cannot be read.

3071 No workspace for I/O record buffer

DOS failed to allocate a requested I/O record buffer.

3072 **Unable to release unused memory to operating system**

An error occurred during the release of memory to DOS at program initialization.

3073 **Error invoking a user command in PAUSE processing**

DOS has indicated a failure to execute a command passed from the operator to DOS.

3074 **Error in releasing previously allocated memory to operating system**

An error occurred during the release of previously allocated memory to DOS.

3075 **Undefined unit for opening a file**

An attempt has been made by the operating system interface to access information from its tables concerning a unit that should have been previously recorded.

3076 **Write error on final use of standard output**

An unsuccessful attempt has been made to write the carriage return/line feed characters to the standard output device, just before program termination.

3077 **Error releasing a filename's storage space to operating system**

An error occurred during the release of a filename's storage space to DOS.

3078 **Cannot find Command Processor name in PAUSE processing**

PAUSE processing executes user commands by invoking a secondary Command Processor whose name should be available in the program's environment.

3079 **Error in getting operating system version**

3080 **Endfile write error**

3081 **Read error on unformatted direct record**

3082 **Read error on unformatted sequential record**

3083 **Unformatted sequential record length error**

An unformatted sequential record has been read according to the length found in the 4-byte header, but the 4-byte trailer does not match the header.

3084 **Write error on unformatted direct record**

3085 **Write error on unformatted sequential record**

3086 **Unformatted record too long**

See the /R runtime option in "Starting Your Program" in Chapter 2, "Compile, Link, and Run."

3087 **Read error on formatted sequential record**

Miscellaneous

Number Message

4000 Runtime Error

An internal error has occurred. Inform your IBM Personal Computer supplier and provide a complete set of relevant source, object, and load files.

4001 PROFORT requires math coprocessor

Your IBM Personal Computer is not configured with the appropriate math coprocessor.

4002 Incorrect DOS Version

Your version of DOS is 2.00 or earlier. Replace it with DOS 2.10 (or a later version).

Debug I/O

Number Message

5001 I/O error closing Debug file

5002 I/O error reading Debug file

5003 Unexpected EOF on Debug command file

The END command is assumed.

5004 I/O error writing Debug file

5005 Must have a /T compiled main program for Debug

DOS System Return Codes for Runtime

The DOS system return code is set to indicate the result of the program execution. Return codes and their meanings are:

Code	Meaning
0	Normal termination with no STOP statement or a stop statement with no arguments
1	Normal termination with a STOP statement that has an argument which is a character string, or a numeric value > 255
n	Normal termination with a STOP statement that has a numeric value *n* where $0 < n < 256$
252	Terminated because of error reading error message file
253	Attempted to execute statement with compile time error
254	Canceled <BREAK>
255	General runtime error termination, an example would be an I/O runtime error

These codes can be tested using the DOS batch IF ERRORLEVEL facility. See the IBM Personal Computer *DOS Reference* Manual for more information.

> **Note:** Loading and executing a program which has a runtime return code greater than 250 will have undefined results.